Exhibit A

United States Bankruptcy Court
Southern District of New York
Delphi Corporation et al. Claims Processing
c/o Kurtzman Carson Consultants LLC, 2335 Alaska Avenue
El Segundo, California 90245

Administrative Expense Claim Form

Debtor against which claim is asserted :
Delphi Corporation, *et al.* 05-44481

Case Name and Number
In re Delphi Corporation., *et al.* 05-44481
Chapter 11, Jointly Administered

NOTE: This form should not be used to make a claim in connection with a request for payment for goods or services provided to the Debtors prior to the commencement of the case. This Administrative Expense Claim Form is to be used solely in connection with a request for payment of an administrative expense arising after commencement of the case but prior to June 1, 2009, pursuant to 11 U.S.C. § 503.

COPY

Name of Creditor
(The person or other entity to whom the debtor owes money or property)
Autoliv, ASP, Inc.

Name and Address Where Notices Should be Sent
c/o Marc N. Swanson
Miller Canfield Paddock & Stone PLC
150 West Jefferson Ave., Suite 2500
Detroit, MI 48226

Telephone No.
313.496.7591

☐ Check box if you are aware that anyone else has filed a proof of claim relating to your claim. Attach copy of statement giving particulars.
☐ Check box if you have never received any notices from the bankruptcy court in this case.
☐ Check box if the address differs from the address on the envelope sent to you by the court.

THIS SPACE IS FOR COURT USE ONLY

ACCOUNT OR OTHER NUMBER BY WHICH CREDITOR IDENTIFIES DEBTOR:

Check here if this claim ☐ replaces ☐ amends a previously filed claim, dated: ___

1. BASIS FOR CLAIM
☐ Goods sold
☐ Services performed
☐ Money loaned
☐ Personal injury/wrongful death
☐ Taxes
X Other (Describe briefly) Infringement on Patent (see attached)
☐ Retiree benefits as defined in 11 U.S.C. § 1114(a)
☐ Wages, salaries, and compensation (Fill out below)
Your social security number ___
Unpaid compensation for services performed
from ___ (date) to ___ (date)

2. DATE DEBT WAS INCURRED From petition date and ongoing

3. IF COURT JUDGMENT, DATE OBTAINED:

4. TOTAL AMOUNT OF ADMINISTRATIVE CLAIM: $ 1,069,444
Check this box if claim includes interest or other charges in addition to the principal amount of the claim. Attach itemized statement of all additional charges.

5. Brief Description of Claim (attach any additional information):
Please see attached.

6. **CREDITS AND SETOFFS**: The amount of all payments on this claim has been credited and deducted for the purpose of making this proof of claim. In filing this claim, claimant has deducted all amounts that claimant owes to debtor.

7. **SUPPORTING DOCUMENTS**: *Attach copies of supporting documents*, such as promissory notes, purchase orders, invoices, itemized statements of running accounts, contracts, court judgments, or evidence of security interests. DO NOT SEND ORIGINAL DOCUMENTS. If the documents are not available, explain. If the documents are voluminous, attach a summary. Any attachment must be 8-1/2" by 11".

8. **DATE-STAMPED COPY**: To receive an acknowledgement of the filing of your claim, enclose a stamped, self-addressed envelope and copy of this proof of claim.

THIS SPACE IS FOR COURT USE ONLY

RECEIVED
JUL 15 2009
KURTZMAN CARSON CONSULTANTS

Date
7/14/2009

Sign and print the name and title, if any, of the creditor or other person authorized to file this claim (attach copy of power of attorney, if any)
Marc N. Swanson, Attorney for Autoliv, ASP, Inc.

Delphi Inflatable Curtain Sales

Model Code	GMT265	GMT360	GMT370	GMX295	GMT191	GMT192	GMT193	GMT345	TOTAL
Car Brand and Name	Cadillac SRX	Chevy Trailblazer GMC Envoy Oldsmobile Bravada Isuzu Ascender Saab	Chevy Trailblazer XL GMC Envoy XL	Cadillac STS	Chevy Equinox	Pontiac Torrent	Suzuki XL-7	Hummer H3	
Estimated price	$60.00	$55.00	$80.00	$60.00	$50.00	$50.00	$50.00	$50.00	
Penetration Rates	100%	30%	30%	100%	40%	30%	50%	75%	
Qty of Parts shipped to date (Estimate)	151 008	371 575	28 598	134 352	289 314	93 576	88 396	212 889	
Infringement Estimate* @ $.80/ Curtain	$120 806	$297 260	$22 878	$107 482	$231 451	$75 180	$44 316	$170 071	[redacted]

Source : CSM-200906NAPAK	GMT 265	GMT360	GMT370	GMX295	GNT191	GMT192	GNT193	GMT345	Grand Total
Oct-Dec 2005	8 411	78 680	30 691	7 258	29 641	21 627			185 108
2 006	25 637	229 242	17 572	24 883	126 074	57 416	13 109	17 788	511 700
2 007	24 474	208 736	-	18 836	165 260	41 478	31 403	56 806	486 993
2 008	16 982	103 233		14 697	83 295	26 433	10 883	49 242	304 765
2009 YTD				1 522	7 372	9 673		17 890	36 457
Grand Total Oct05 to Jul09	75 504	619 291	47 563	67 175	341 642	156 626	85 395	141 726	1 525 023

Exhibit B

US005788270A

United States Patent [19]

HÅland et al.

[11] **Patent Number: 5,788,270**

[45] **Date of Patent: Aug. 4, 1998**

[54] **SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR**

[75] Inventors: **Yngve HÅland**, Falsterbo; **Lars-Erik Florberger**, Lidköping; **Sture Andersson**, Nacka, all of Sweden; **Simomn Valkenburg**, Macclesfield, United Kingdom; **I. Jörgen Svensson**, Saltsjö-Boo, Sweden

[73] Assignee: **Autoliv Development AB**, Vargarda, Sweden

[21] Appl. No.: **604,052**

[22] Filed: **Feb. 20, 1996**

[30] **Foreign Application Priority Data**

Feb. 20, 1995 [GB] United Kingdom 9503267

[51] **Int. Cl.**[6] **B60R 21/22**; B60R 21/24; B60R 21/08

[52] **U.S. Cl.** **280/729**; 280/730.2; 280/749

[58] **Field of Search** 280/730.2, 730.1, 280/729, 743.1, 743.2, 728.1, 753, 749

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,731,949	5/1973	Radke	280/743.1
3,792,873	2/1974	Buchner et al.	280/743.1
3,897,961	8/1975	Leising et al.	280/730.1
4,227,717	10/1980	Bouvier	280/753
5,322,322	6/1994	Bark et al.	280/730.2
5,333,899	8/1994	Witte	280/730.2
5,588,672	12/1996	Karlow et al.	280/730.2

FOREIGN PATENT DOCUMENTS

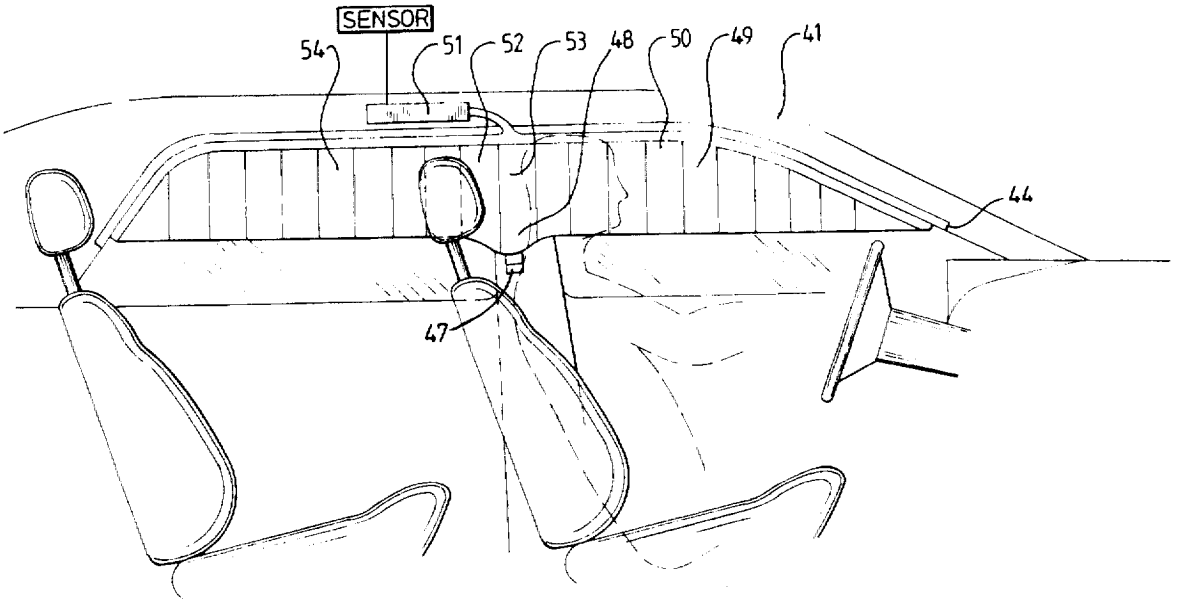
0 584 781	3/1994	European Pat. Off. .	
0590518	4/1994	European Pat. Off. .	
2 222 621	11/1972	German Dem. Rep. .	
41 34 995	3/1993	Germany .	
43 07 175	9/1993	Germany	280/730.2
42 31 522	3/1994	Germany	280/729
5-131889	5/1993	Japan	280/729
962946	7/1964	United Kingdom	280/749
2191450	12/1987	United Kingdom .	
2 261 636	5/1993	United Kingdom .	
2278812	12/1994	United Kingdom .	
90/09295	8/1990	WIPO .	
94/19215	9/1994	WIPO .	

Primary Examiner—Peter C. English
Attorney, Agent, or Firm—Spencer & Frank

[57] **ABSTRACT**

A safety device for a motor vehicle which has a door frame and a door contained within the door frame. The safety device includes: a gas generator; a sensor for sensing at least one of a side impact and a roll-over for activating the gas generator; and an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator. The inflatable element can thus assume a non-inflated mode and an inflated mode and can further be positioned adjacent the door in an inflated-mode thereof. The inflatable element is further made of fabric and includes: a first fabric layer defining a front part thereof; a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together. The inflatable element thus incorporates a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned. The inflatable element further includes an upper edge portion which is configured to be secured to the door frame all along a non-linear part of the door frame.

14 Claims, 5 Drawing Sheets



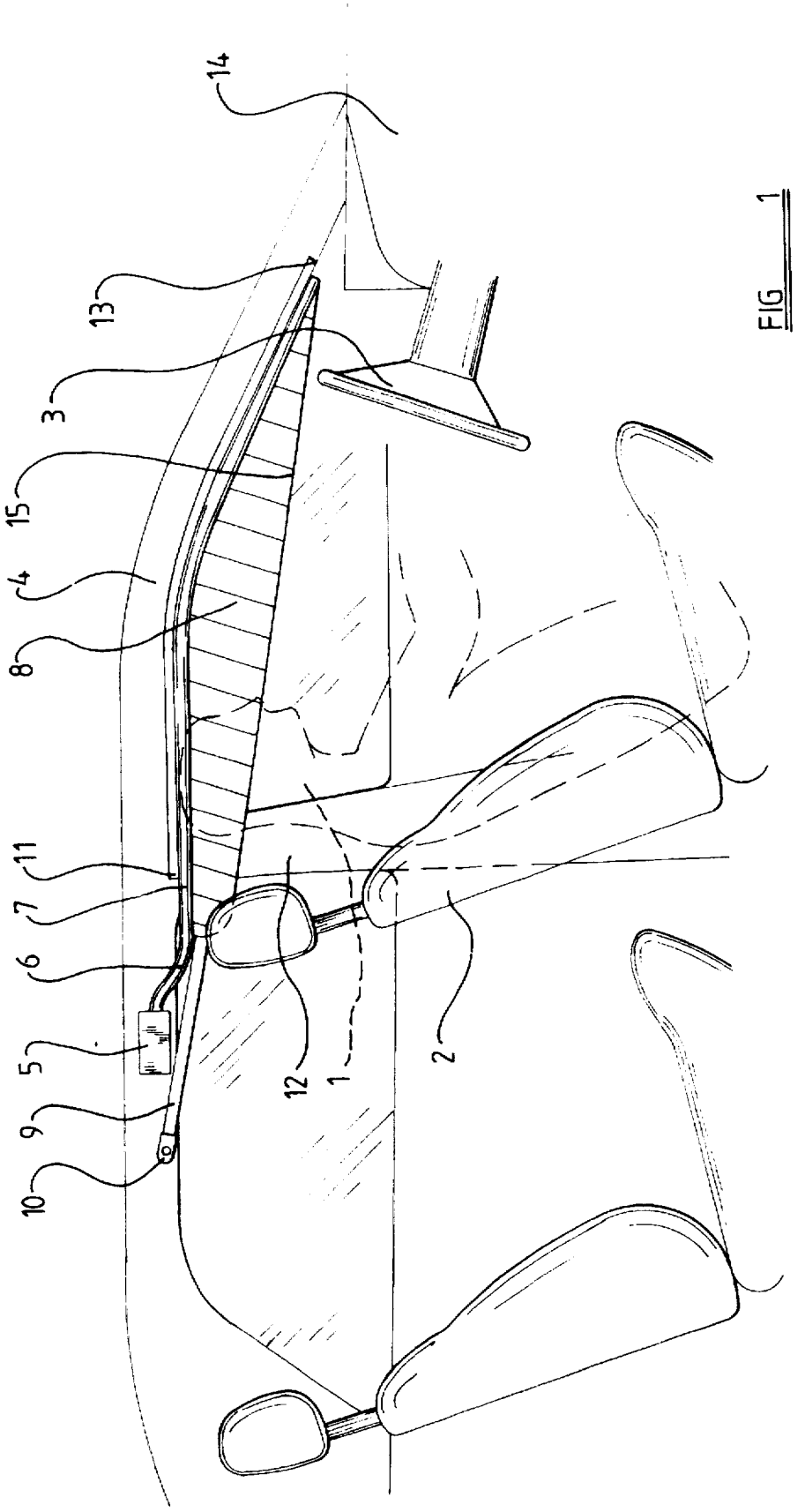


FIG 1

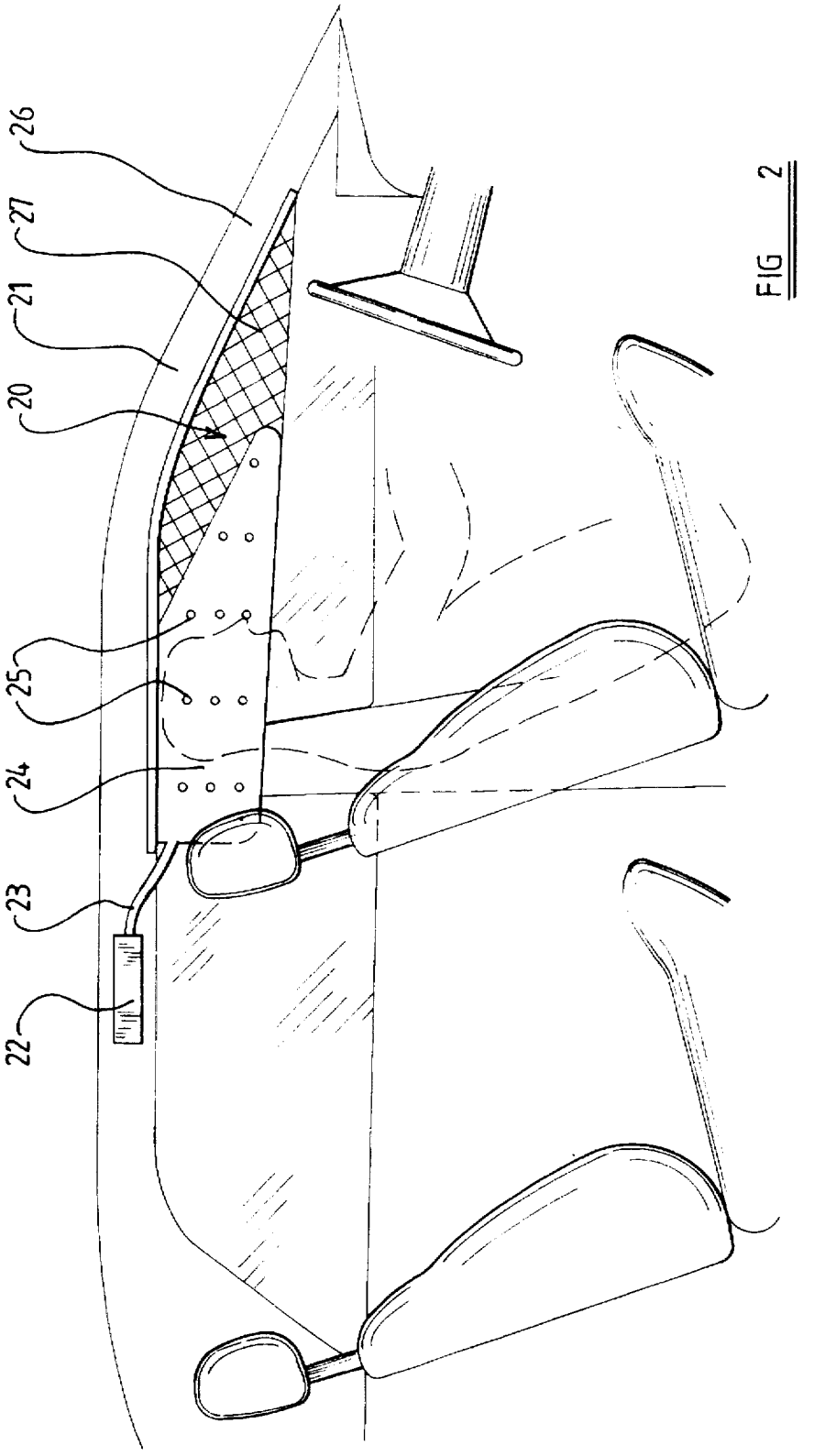


FIG 2

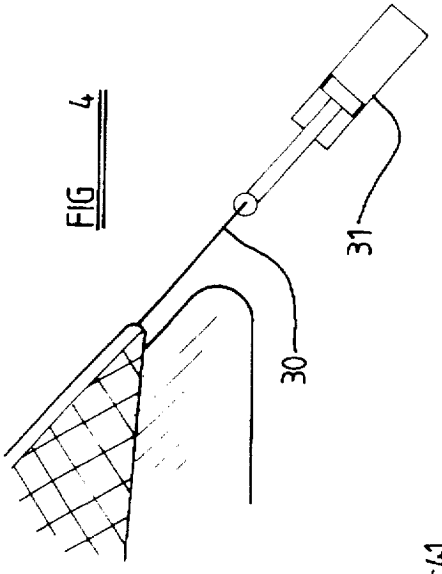


FIG 4

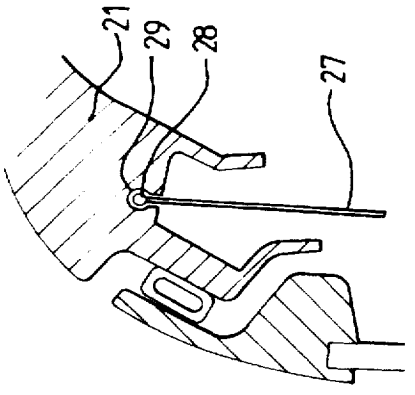


FIG 3

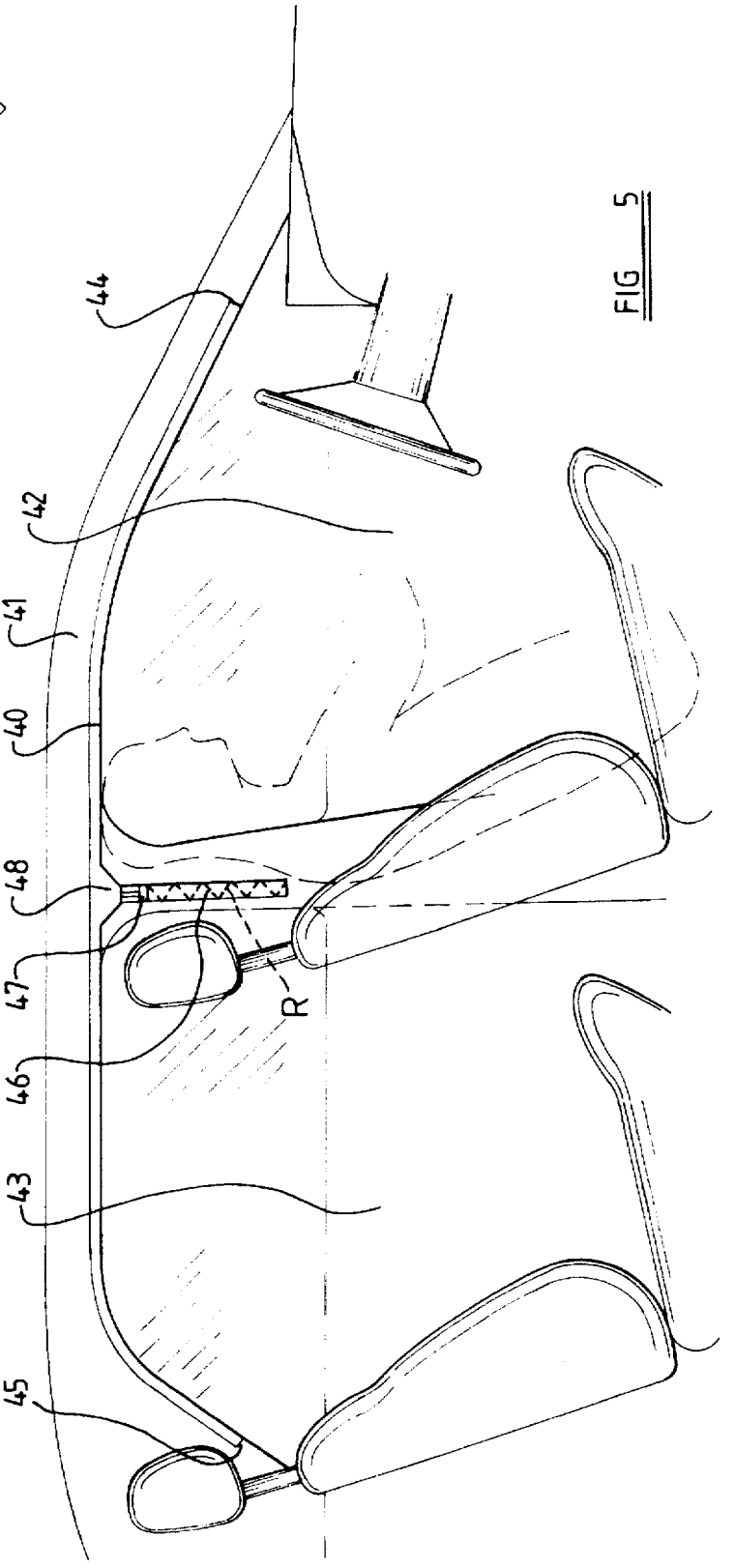


FIG 5

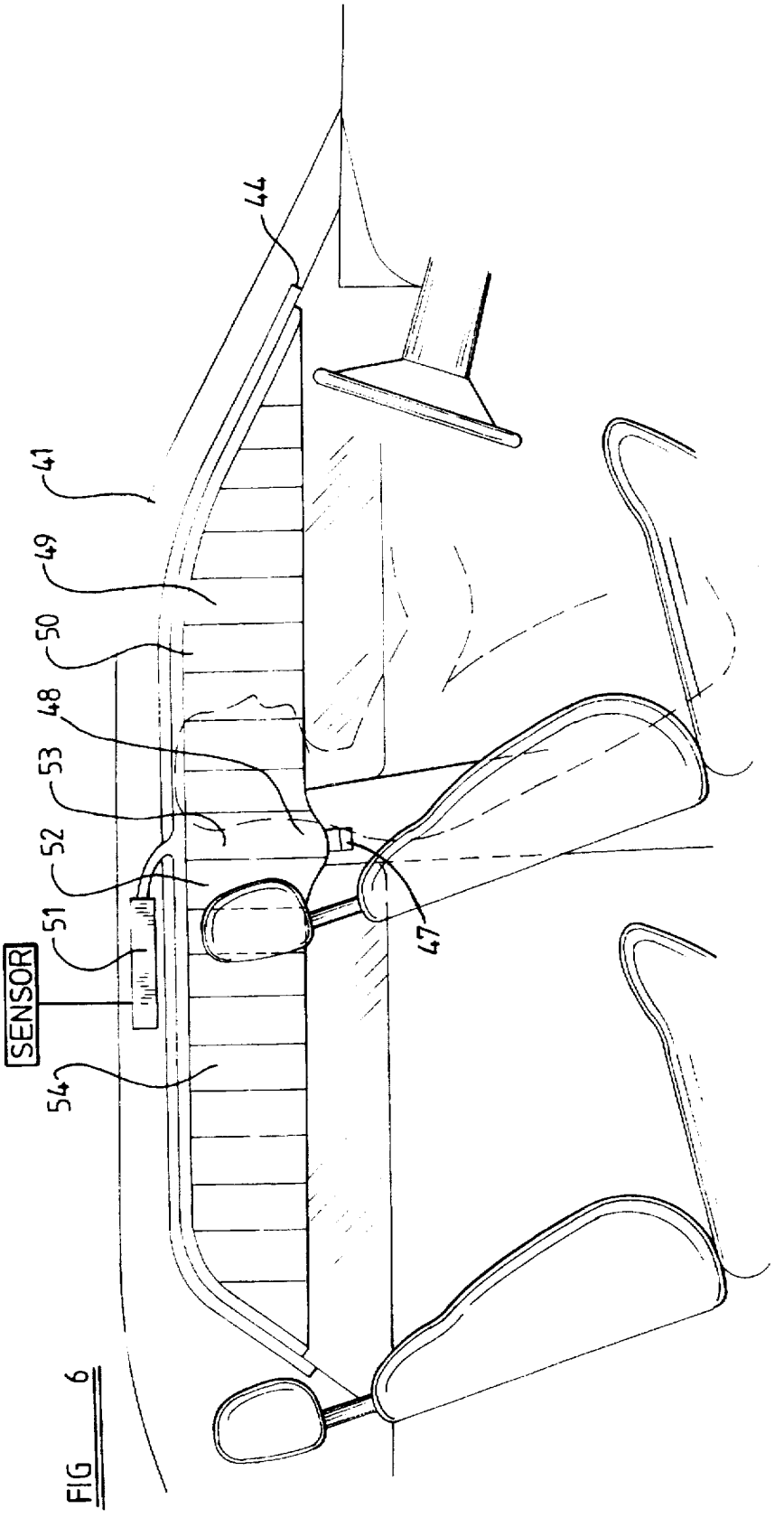


FIG 6

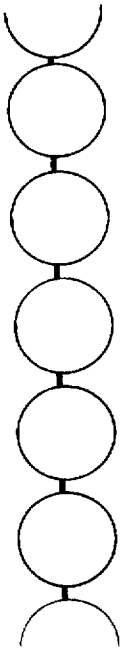


FIG 7

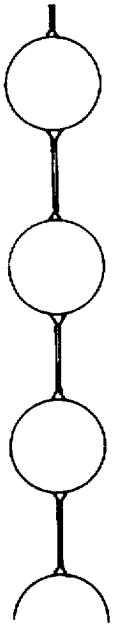


FIG 8

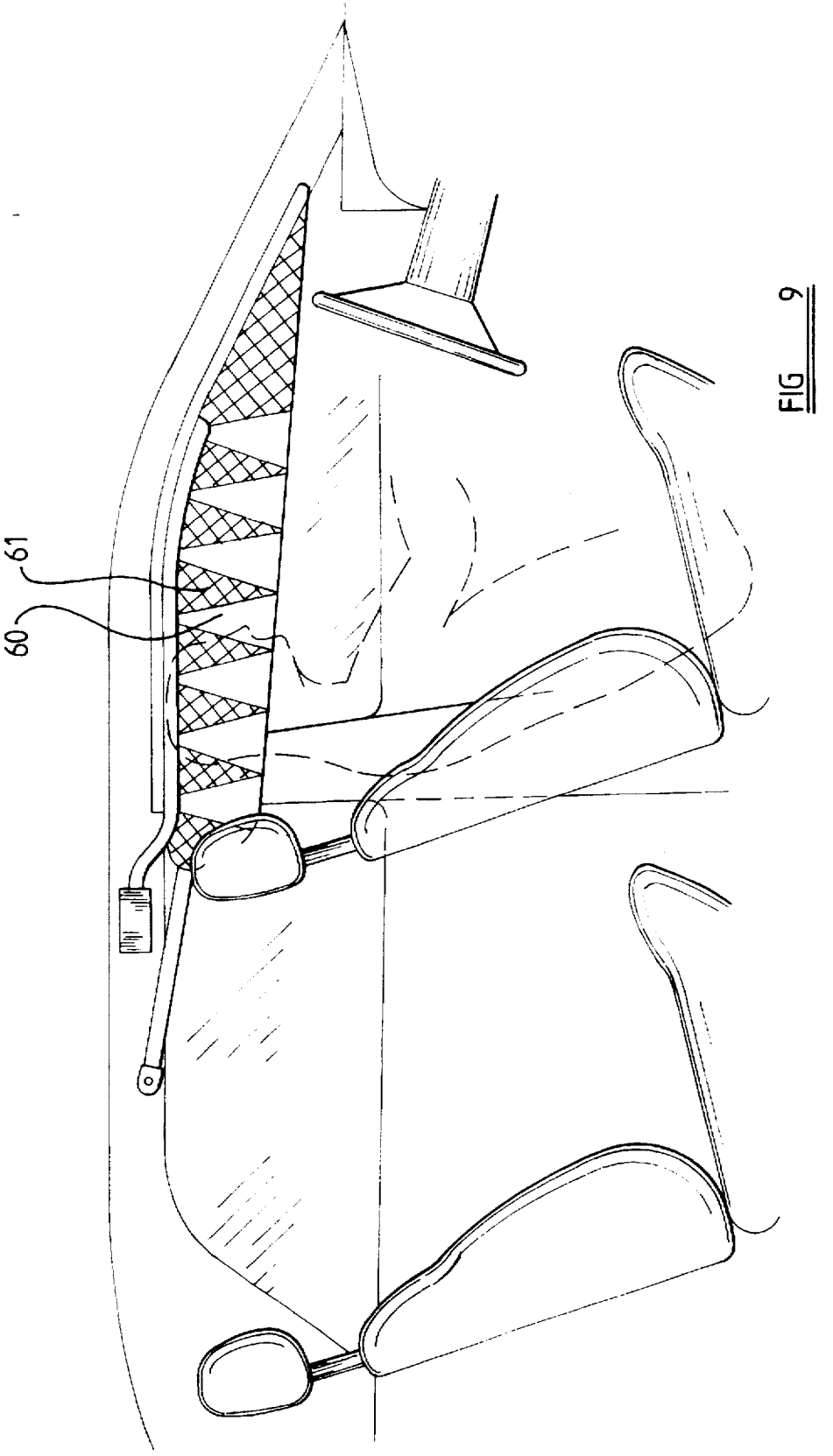


FIG 9

SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR

FIELD OF THE INVENTION

THIS INVENTION relates to a safety device, and more particularly relates to a safety device in a motor vehicle such as a motor car.

BACKGROUND OF THE INVENTION

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured. It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. U.S. Pat. No. 5,322,322 discloses such a device. An inflatable tube is initially stored in a recess in the door frame above the door of the vehicle, and the ends of the tube are pivotally anchored to fixed points on the door frame. A sensor is provided to sense when an accident occurs, and to initiate inflation of the tube. As the tube inflates its length decreases, and it then extends linearly between the two fixed points on the door frame. The inflated tube provides some protection for the head of a person sitting in the vehicle. However, the tube is inflated to a substantial pressure, and thus the head of a person in the vehicle may tend to bounce off the tube. The tube may not cover the whole of the area of the window, and may not even cover the whole of the upper part of the window. There is thus a risk that the head of the person in the vehicle may move past the tube and pass through the window opening. If a car is rolling over this is very undesirable.

SUMMARY OF THE INVENTION

This invention seeks to provide an improved safety device.

According to this invention there is provided a safety device in a motor vehicle, the device comprising a gas generator, incorporating or associated with a sensor adapted to sense a side impact or a roll-over and to activate the gas generator, and an inflatable element connected to the gas generator to be inflated by gas from the gas generator, the inflatable element being made of fabric comprising a first layer to define the front part of the inflatable element, and a second layer to define the back part of the inflatable element, selected parts of the first layer and the second layer being inter-connected to define points or lines where the front part and back part of the inflatable element are secured together, the inflatable element incorporating a plurality of substantially parallel elongate cells, the inflatable element having an edge portion secured to part of the door frame of the vehicle which is non-linear, the inflatable element, when inflated, being positioned adjacent the door contained within the door frame.

The inflatable element, when inflated, is thus located between the head of a person sitting in the vehicle and an adjacent door. Usually such a door is provided with a window and so the inflated element provides protection from breaking glass from the window, and also prevents the head of the person in the vehicle from striking the window, or from being thrown out through the window, as can happen, particularly with roll-over accidents.

Preferably the safety device is usually initially stored in a recess provided in the doorframe.

Preferably the inflatable element is made of interwoven fabric layers, the selected parts of the first layer and the second layer being inter-woven. Preferably there is internal venting between the cells as this may reduce undesirable bounce that might occur if the cells were discrete and not vented to each other.

The cells may be immediately adjacent each other or may be spaced apart. At least some of the cells may be of conical form when inflated.

The inflatable element may be formed of a fabric with parts of the fabric being interwoven to form the cell or cells. The fabric may have a single layer weight of less than 300 g/sq m, such as a weight of 175 g/sq m.

Preferably when the inflatable element is inflated the pressure of gas is approximately 3 bar. Preferably the inflatable element, when inflated, extends past the B-post of the vehicle, to provide protection for the head of the driver. If the head of the driver should impact with the B-post in an accident the consequences could be fatal.

In one embodiment the inflatable element incorporates a strap to connect part of the inflatable element to the door-frame. The strap is tight, that is, tensioned to a significant extent, when the inflatable element is inflated.

Separate means may be provided to apply tension to part of the inflatable element then it is inflated, such as a piston and cylinder, adapted to be moved by gas from a gas generator when the inflatable element is inflated, to apply tension to one edge of the inflatable element, to hold the inflated element in a desired position.

In one embodiment the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain the means in the further position. Thus a slider may be provided adapted to slide along a ratchet, and to be retained by the ratchet when it has moved to a further position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and so that further features thereof may be appreciated the invention will now be described by way of example with reference to the accompanying drawings in which

FIG. **1** is a side view of the interior of a motor vehicle illustrating a safety device in accordance with the invention in an operative state,

FIG. **2** is a side view of part of the interior of a motor vehicle illustrating another safety device in accordance with the invention in the operative state,

FIG. **3** is a sectional view of part of the embodiment of FIG. **2** in a plane perpendicular to a longitudinal axis of the vehicle,

FIG. **4** is a view of part of FIG. **2** showing an additional component of the safety device,

FIG. **5** is a side view of the interior of a motor vehicle provided with another form of safety device in accordance with the invention, before the safety device moves to the operative state,

FIG. **6** illustrates the vehicle of FIG. **5** when the safety device is in the operative state,

FIG. **7** is a sectional view of one form of safety device as shown in FIG. **1** or in FIGS. **5** and **6** in a plane perpendicular to a longitudinal axis of the vehicle,

FIG. **8** is a sectional view of another form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, and

FIG. **9** is a view of part of an alternative inflatable element for use in the embodiments of FIGS. **1**, **5** and **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. 1 a safety device is illustrated which is intended to provide protection for a person 1 sitting in a seat 2 in the vehicle. In any accident in which the vehicle is decelerated the person will tend to move forwardly towards the steering wheel 3, but will be restrained by a conventional seat belt or air-bag. In the case of a side impact or roll-over, there is a risk that the head of the person 1 will strike the window in the door beside the person, or strike the B-post. There is also a risk that if, as most commonly happens, the glass in the window should break, the head of the person 1 may be thrown out of the window, especially in the case of roll-over.

The safety device shown in the operative state in FIG. 1 is initially retained in a recess provided in the door frame 4 located above the door of the vehicle. The recess extends over more than simply a linear portion of the door frame so that the two ends of the recess are not in alignment with the main part of the recess.

The safety device comprises a gas generator 5, which is adapted to generate gas, such as cold gas. The gas generator incorporates, or is associated with, a sensor which senses a side impact and/or a roll-over situation to activate the gas generator at an appropriate instant. The gas generator is connected by a hose 6 to a duct 7. The duct 7 forms part of an inflatable element. The inflatable element incorporates a plurality of parallel substantially vertical, substantially cylindrical cells 8. The inflatable element may be made of interwoven fabric. Such a fabric comprises a first layer that defines the front of the inflatable element—that is to say the part that is visible in FIG. 1—and a second layer that defines the back part—that is to say the part that is adjacent the window in FIG. 1—selected parts of the first region and the second region being interwoven to define links in the form of points or lines where the front part and the back part of the inflatable element are secured together. A technique for making an inflatable element of inter-woven fabric is described in more detail in International Patent Publication W090/09295.

A webbing strap 9 that forms part of the inflatable element extends from the end of the inflatable element near the duct 7 which is connected to the hose 6 to an anchoring point 10 on the door frame 4. The edge of the duct 7 between the points 11, adjacent the top of the B-post 12, and 13, at the lower part of the A-post, in the region of the dashboard 14, is fixed securely to the door frame 4. consequently, it is to be understood that the upper edge of the inflatable element has a non-linear configuration which conforms with the non-linear configuration of the upper part of the door frame 4 by virtue of the inflatable element being secured, at an upper edge portion thereof, to the door frame all along a non-linear part of the door frame as shown in the figures. A substantial part, in fact virtually all, of the upper edge of the inflatable element is secured to the upper part of the door frame.

When an accident such as side impact occurs the gas generator generates cold gas which passes through the hose 6 to the duct 7, and then inflates the cells 8. The inflatable element thus moves from its initial stored position within the recess in the door frame to the operative position shown in FIG. 1. The inflatable element then extends downwardly from the top of the door frame to form a flat structure located between the head of the person 1 and the adjacent window. As the cylindrical cells inflate the length of the lower edge 15 of the inflatable element is reduced, and thus the lower edge, together with the webbing strap 9 extend substantially tightly from the point 10 to the point 13. It is to be noted that the part of the doorframe 4 between the points 10 and 13 is not linear, and defines, with the linear lower edge of the inflated element, a triangular area which is covered by the inflated element.

The lower edge of the inflated element decreases by about 10% between the uninflated state and the inflated state. The inflated element is fully inflated within about 15 ms. The total thickness of the inflated element, when inflated is approximately 30–40 mm. The seams of interweaving of the front part and the back part of the inflated element are approximately 30–40 mm apart, so that the resultant cells are cylindrical when inflated. The total volume of gas within the inflated element may be between 7 and 9 litres, and the gas may be at a pressure of about 3 bar. While the inflated element is not provided with a vent to vent gas from within the element to the atmosphere, so that the inflated element, when inflated, remains inflated for a long period of time—to provide protection in the case of a protracted roll-over—there is venting between at least selected adjacent cells 8, to avoid any severe rebound. Thus if the head of the person in the vehicle impacts with the inflated element the pressure of gas within the whole element, or at least a substantial part of the element will rise, thus giving a "soft" impact. If each cell were sealed with no venting of this type, there would be a risk of severe rebound.

The weight of the fabric should be kept to be as low as possible, so that if the inflatable element should impact with the head of the person in the vehicle as the inflatable element is inflated no harm will be done. It is thought that a material having a weight of less that 300 g/sq m, such as 175 g/sq m may be used.

It is to be noted that part of the inflated element extends rearwardly beyond the point 11, and is thus located between the head of the person 1 and the top of the B-post. Thus the risk of the head of the person impacting with the B-post is minimised. Since the upper edge of the inflatable element is secured to the upper part of the door frame along substantially the whole of its length, there is virtually no risk that the head of the occupant will pass between the upper edge of the inflatable element and the upper part of the door frame, with the head of the occupant of the vehicle thus inadvertently emerging from the body shell of the vehicle.

FIGS. 2 to 4 illustrate a second embodiment of the invention. In this embodiment an inflatable element 20 is provided which is initially stored in a recess provided in the door frame 21 of a motor vehicle. A gas generator 22 is provided, which again incorporates or is associated with a sensor or detector which activates the gas generator at an appropriate time. The gas generator is connected by a duct 23 to an inflatable part 24 of the inflatable element 20. The gas generator 22 is located in the door frame 21 of the vehicle, but alternatively could be positioned in the B-post.

The inflatable part 24 of the inflatable element 20 is formed from two layers of fabric, as in the embodiment of FIG. 1, with the front layer and the back layer of the fabric being woven together at selected points 25. The selected points 25 are arranged in vertically extending columns and serve to divide the inflatable part 24 into a plurality of vertical parallel chambers. The spaces between the selected points 25 permit internal venting between adjacent chambers.

The inflatable part 24 of the inflatable element 20 is adapted to be located adjacent the head of an occupant of the motor vehicle, and, towards the rear of the inflatable

element, when in the position illustrated in FIG. **2**, the inflatable part of the inflatable element extends from the top to the bottom of the inflatable element in a rear region and subsequently, the upper edge of the inflatable part extends downwardly towards the lower edge of the inflatable element, in a sense directed towards the A-Post **26**. The remaining part of the inflatable element comprises a web or sheet **27** which extends from the inflatable part **24** to the part of the door frame **21** above the door and to the A-post. The web or sheet **27** is thus secured to parts of the doorframe that are non-linear. It is to be appreciated, therefore, that in this embodiment of the invention the upper edge of the inflatable element is of non-linear form and is of the same configuration as the non-linear part of the door frame which extends forwardly from the B-post and which incorporates the A-post. The upper edge of the inflatable element, or at least a substantial part of that upper edge, is securely fixed to the upper part of the door frame, thus again minimizing any risk of the head of the occupant emerging from the body shell between the upper edge of the inflatable element and the upper part of the door frame.

Referring to FIG. **3** the edge of the sheet **27** that is secured to the door frame **21** may terminate with a bead **28** that is received within a slot **29** formed in the door frame, the mouth of the slot being narrower than the base so that the bead **28** can slide axially within the slot, but cannot escape from the slot. A cable **30** is connected to the end of the bead, as can be seen in FIG. **4**, the cable being connected to a tensioning device **31**. The tensioning device may comprise a piston in a cylinder associated with a gas generator to generate gas which moves the piston within the cylinder to apply tension to the cable **30** and thus to the bead **28**. A ratchet or the like may hold the piston in place when it has been moved by the gas. The gas generator that supplies gas to the piston may be the gas generator **22** or may be a separate gas generator that is triggered simultaneously with the main gas generator.

When an accident occurs the inflatable element **20** moves from its stored position to the operative position shown in FIG. **2**, and tension is applied to the inflatable element **20** by the distension of the inflatable part **24**, and by the tension applied to the bead **28**. The inflated element **20** is thus held firmly in position to provide protection for the head of the person sitting in the motor vehicle. The thickness of the element **20** and the weight of the material used should be as described with reference to the embodiment of FIG. **1**.

FIGS. **5** and **6** illustrate another embodiment of the invention intended to provide protection not only for a person in the front seat of a motor vehicle such as a motor car, but also for a person in the rear seat of the vehicle.

Referring to FIG. **5**, a recess **40** is provided in the doorframe **41** of a motor vehicle, the recess extending over both the front door **42** and the rear door **43**. The recess extends from a point **44** located near the lower end of the A-post to a point **45** located near the lower end of the C-post.

A channel **46** is provided on the B-post, extending vertically. In the channel **46** is a ratchet R, and received within the upper end of the channel **46** is a ratchet engaging slide member **47**. The slide member **47** is connected to a tab **48** which forms part of an inflatable element **49**, which is initially stored within the recess **40**.

The inflatable element **49** (see FIG. **6**) is shown in the inflated state in FIG. **6**.The inflatable element has its top edge **50** secured to the part of the door frame **41** that extends above the doors **42**, **43** of the motor vehicle. The top edge of the inflatable element is of non-linear configuration, and has a configuration which corresponds with the nonlinear configuration of the upper part of the door frame. The design of the inflatable element is similar to that shown in FIG. **1**, with the inflatable element presenting a plurality of parallel cells, which when inflated are substantially cylindrical. The structure of the inflatable element **49** may be the same as that described with reference to FIG. **1**.

A gas generator **51** is provided which is connected to the inflatable element in such a way that when the gas generator is activated by a sensor that is formed integrally with the gas generator, or which is associated with the gas generator, and which responds to a side impact or to a roll-over situation to activate the gas generator, gas is initially supplied to the cells **52**, **53**, which are aligned with the tab **48**. Thus initially, as the inflatable element **49** inflates, the cells **52** and **53** inflate and move the ratchet engaging slide member **47** downwardly. The ratchet engaging slide member thus moves down the slot **46** to the position shown in FIG. **6**. The ratchet engaging slide member **47** engages the ratchet, and thus holds the tab **48** in its lower position.

The rest of the cells **54** of the inflatable element are then inflated, and the inflatable element then extends fully across the upper parts of the windows in the doors **42**, **43** of the motor vehicle. It can be seen that the lower edge of the inflated element **49** extends between the points **44** and **45** at the ends of the recess **40**. As the inflatable element **49** inflates, so the length of the lower edge thereof decreases as a consequence of the inflation of the cells of the inflatable element. This reduction in the length of the lower edge, together with the action of the ratchet engaging slide member **47** ensures that the inflated element is retained in position as illustrated after it has been inflated.

FIG. **7** is a cross section showing the nature of the cells of the inflated element of FIG. **1** and of FIGS. **5** and **6**. It can be seen that the cells are immediately adjacent to each other and are only separated by narrow regions where the fabric forming the front part of the inflated element has been woven with the fabric forming the back part of the inflated element. However, FIG. **8** illustrates an alternative possibility, in which the regions of fabric between the cells that are woven together are relatively wide, the cells thus being separated by webs of fabric. The advantage of this latter possibility is that a smaller volume of gas may be required to fully inflate the inflatable element, meaning that the inflatable element may be inflated more rapidly.

FIG. **9** illustrates an alternative form of inflatable element comprising a plurality of cells **60**. The upper edge of the inflatable element is of non-linear form and is connected to the non-linear portion of the door frame above the door. The configuration of the upper edge of the inflatable element and the configuration of the door frame correspond. It can be seen that each cell **60** is of substantially conical form, the cells being arranged adjacent each other and being parallel with each other. Between the cells are inverted triangular portions **61** where the fabric forming the cells is interwoven.

When cells of this type are inflated, the length of the lower edge of the arrangement contracts, whereas the length of the upper edge of the arrangement remains constant.

An arrangement of this type can be used, therefore, to ensure that the lower edge of the element, when inflated, is under some tension.

Whilst in the arrangement illustrated in FIG. **9**, the cells are immediately adjacent each other, it is to be appreciated that a similar effect may be achieved if the cells are spaced apart. It is possible to replace at least part of the inverted triangular region **61** with further conical cells of an inverted orientation.

Whilst in the described embodiments of the invention, the inflatable element has been described as being made utilising a technique in which two layers of fabric are inter-woven to define points or lines where the front layer and the rear layer are inter-woven, it would be possible to form embodiments of the invention utilising two discrete layers of fabric which are inter-connected by stitching.

We claim:

1. A safety device for a motor vehicle having a door frame, a door contained within the door frame, and a B-post, the safety device comprising:

a gas generator;

a sensor operatively connected to the gas generator for sensing at least one of a side impact and a roll-over for activating the gas generator; and

an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator, the inflatable element thereby being adapted to be in a non-inflated mode and in an inflated mode and further being adapted to be positioned adjacent the door in the inflated mode thereof, the inflatable element further being made of fabric and comprising:

a first fabric layer defining a front part thereof;

a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together, the inflatable element thereby incorporating a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned; and

an upper edge portion adapted to be secured to the door frame all along a non-linear part of the door frame, the cells being configured to extend substantially from the upper edge portion of the inflatable element to the lower edge portion of the inflatable element.

2. The safety device according to claim 1, wherein the inflatable element, in its non-inflated mode, is adapted to be stored in a recess of the door frame.

3. The safety device according to claim 1, wherein the first fabric layer and the second fabric layer are interconnected at the selected parts thereof by being interwoven with one another at the respective links.

4. The safety device according to claim 1, wherein the cells are configured to be in gas flow communication with one another.

5. The safety device according to claim 1, wherein the cells are immediately adjacent each other.

6. The safety device according to claim 1, wherein the cells are spaced apart with respect to one another.

7. The safety device according to claim 1, wherein at least some of the cells have a conical shape in the inflated mode of the inflatable element.

8. The safety device according to claim 1, wherein the inflatable element is made of a fabric having a single layer weight of less than 300 g/sq m.

9. The safety device according to claim 1, wherein a pressure in the inflatable element is approximately 3 bar when the inflatable element is in its inflated mode.

10. The safety device according to claim 1, wherein the inflatable element, in its inflated mode, is adapted to extend past the B-post of the vehicle.

11. The safety device according to claim 1, further comprising a strap connected to a part of the inflatable element and further adapted to connect the part of the inflatable element to the door frame.

12. The safety device according to claim 1, further comprising a tensioning device for applying tension to the inflatable element when the inflatable element is in its inflated mode.

13. The safety device according to claim 1, further comprising position retaining means connected to a part of the inflatable element for retaining a position of the part of the inflatable element on the door frame when the inflatable element is in its inflated mode, the position retaining means comprising:

a component adapted to move from an initial position to a further position upon inflation of the inflatable element; and

means operatively connected to the component for retaining the component in the further position.

14. A safety device for a motor vehicle having a door frame and both a front door and a rear door contained within the door frame, the safety device comprising:

a gas generator;

a sensor operatively connected to the gas generator for sensing at least one of a side impact and a roll-over for activating the gas generator; and

an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator, the inflatable element thereby being adapted to be in a non-inflated mode and in an inflated mode and further being adapted to be positioned adjacent both the front door and the rear door in the inflated mode thereof, the inflatable element further being made of fabric and comprising:

a first fabric layer defining a front part thereof;

a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together, the inflatable element thereby incorporating a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned; and

an upper edge portion adapted to b e secured to the door frame all along a non-linear part of the door frame which extends over both the front door and the rear door, the cells being configured to extend substantially from the upper edge portion of the inflatable element to the lower edge portion of the inflatable element.

* * * * *

Exhibit C

US006623031B2

(12) **United States Patent**
Haland et al.

(10) **Patent No.: US 6,623,031 B2**
(45) **Date of Patent: *Sep. 23, 2003**

(54) **SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR**

(75) Inventors: **Yngve Haland**, Falsterbo (SE); **Lars-Erik Florberger**, Lidköping (SE); **Sture Andersson**, Nacka (SE); **Simomn Valkenburg**, Macclesfield (GB); **I. Jörgen Svensson**, Saltsjö-Boo (SE)

(73) Assignee: **Autoliv Development AB**, Vargarda (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **10/284,155**

(22) Filed: **Oct. 31, 2002**

(65) **Prior Publication Data**

US 2003/0047921 A1 Mar. 13, 2003

Related U.S. Application Data

(63) Continuation of application No. 09/964,573, filed on Sep. 28, 2001, now Pat. No. 6,494,480, which is a continuation of application No. 09/589,402, filed on Jun. 8, 2000, now Pat. No. 6,312,009, which is a continuation of application No. 09/127,918, filed on Aug. 3, 1998, now Pat. No. 6,099,029, which is a continuation of application No. 08/604,052, filed on Feb. 20, 1996, now Pat. No. 5,788,270.

(30) **Foreign Application Priority Data**

Feb. 20, 1995 (GB) 9503267

(51) **Int. Cl.**[7] **B60R 21/22**; B60R 21/24

(52) **U.S. Cl.** **280/729**; 280/730.2

(58) **Field of Search** 280/730.2, 730.1, 280/729, 743.1, 743.2, 728.1, 753, 749

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,731,949	A	5/1973	Radke
3,792,873	A	2/1974	Buchner et al.
3,897,961	A	8/1975	Leising et al.

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

DE	2222621	11/1972
DE	4134995	3/1993
DE	4307175	9/1993

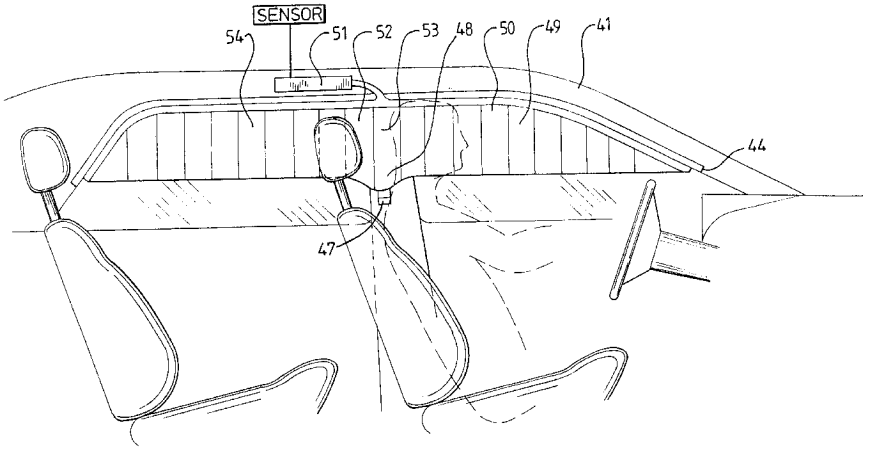
(List continued on next page.)

Primary Examiner—Peter C. English
(74) *Attorney, Agent, or Firm*—Venable LLP; Robert Kinberg; Catherine M. Voorhees

(57) **ABSTRACT**

A safety device for a motor vehicle which has a door frame and a door contained within the door frame. The safety device includes: a gas generator; a sensor for sensing at least one of a side impact and a roll-over for activating the gas generator; and an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator. The inflatable element can thus assume a non-inflated mode and an inflated mode and can further be positioned adjacent the door in an inflated-mode thereof. The inflatable element is further made of fabric and includes: a first fabric layer defining a front part thereof; a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together. The inflatable element thus incorporates a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned. The inflatable element further includes an upper edge portion which is configured to be secured to the door frame all along a non-linear part of the door frame.

6 Claims, 5 Drawing Sheets



U.S. PATENT DOCUMENTS

4,227,717	A	10/1980	Bouvier
5,322,322	A	6/1994	Bark et al.
5,333,899	A	8/1994	Witte
5,588,672	A	12/1996	Karlow et al.

FOREIGN PATENT DOCUMENTS

DE	4231522	3/1994
EP	0584781	3/1994
EP	0590518	4/1994
GB	962946	7/1964
GB	2191450	12/1987
GB	2261636	5/1993
GB	2278812	12/1994
JP	5-131889	5/1993
WO	90/09295	8/1990
WO	94/19215	9/1994

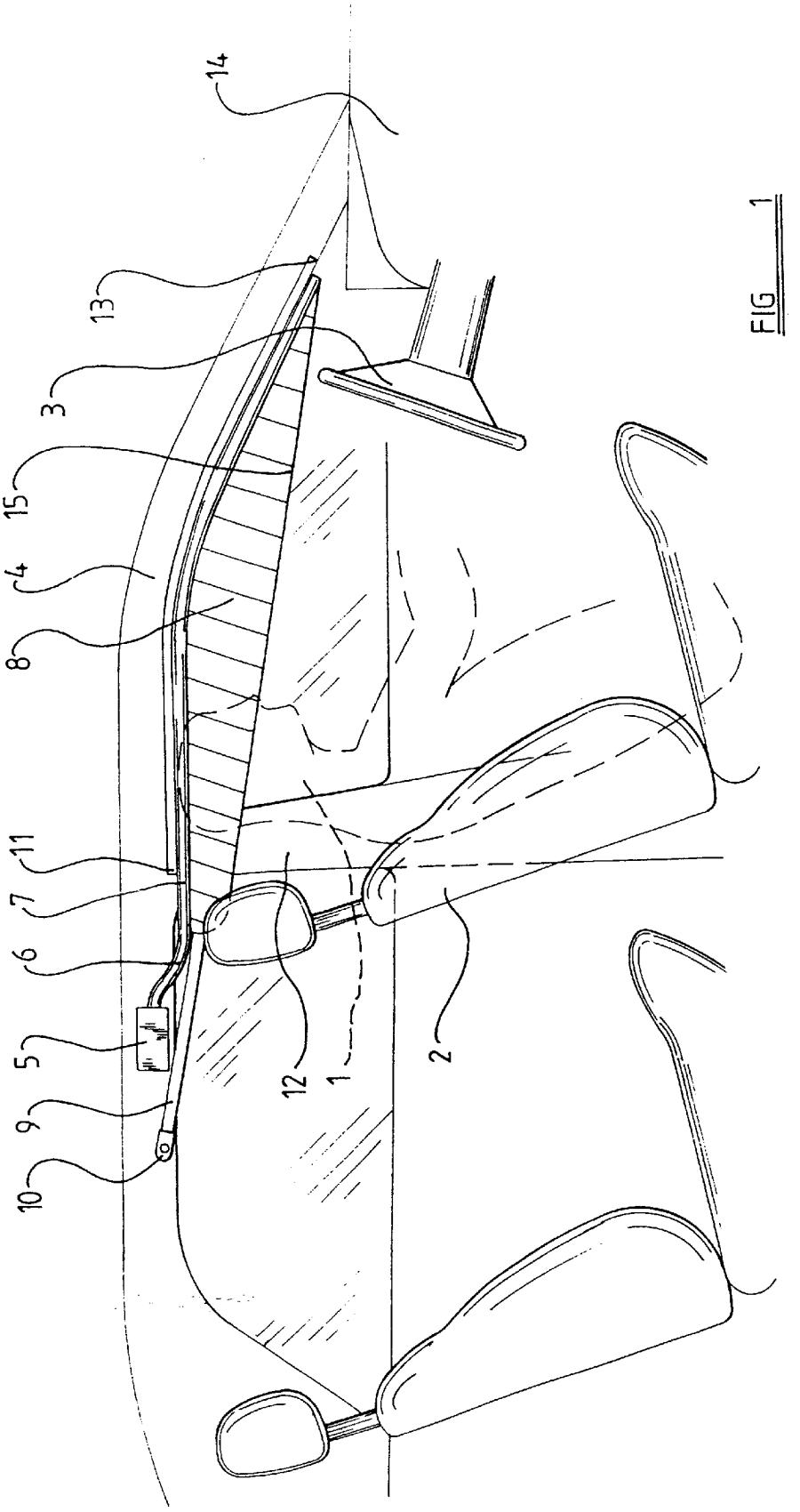


FIG 1

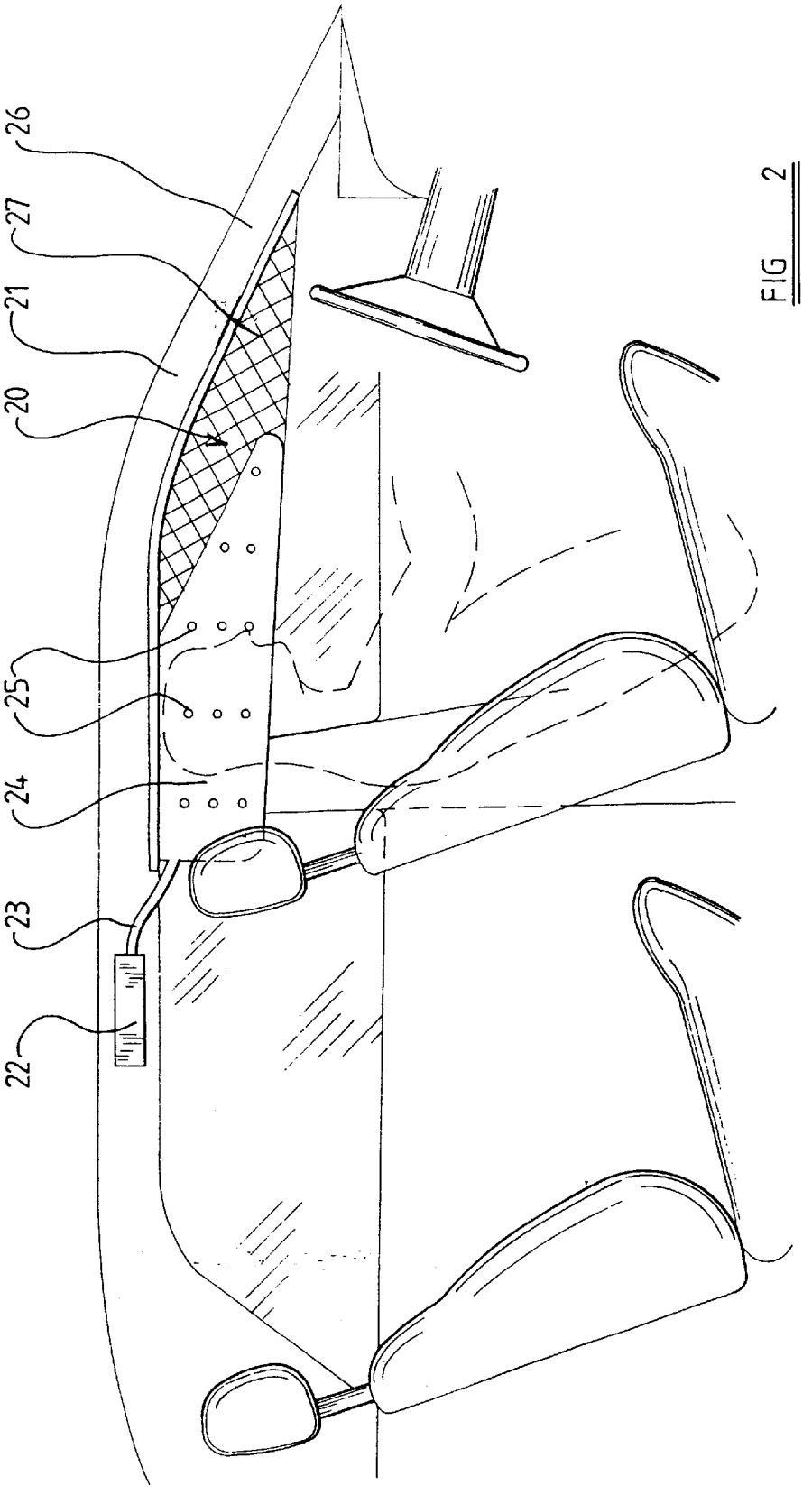


FIG 2

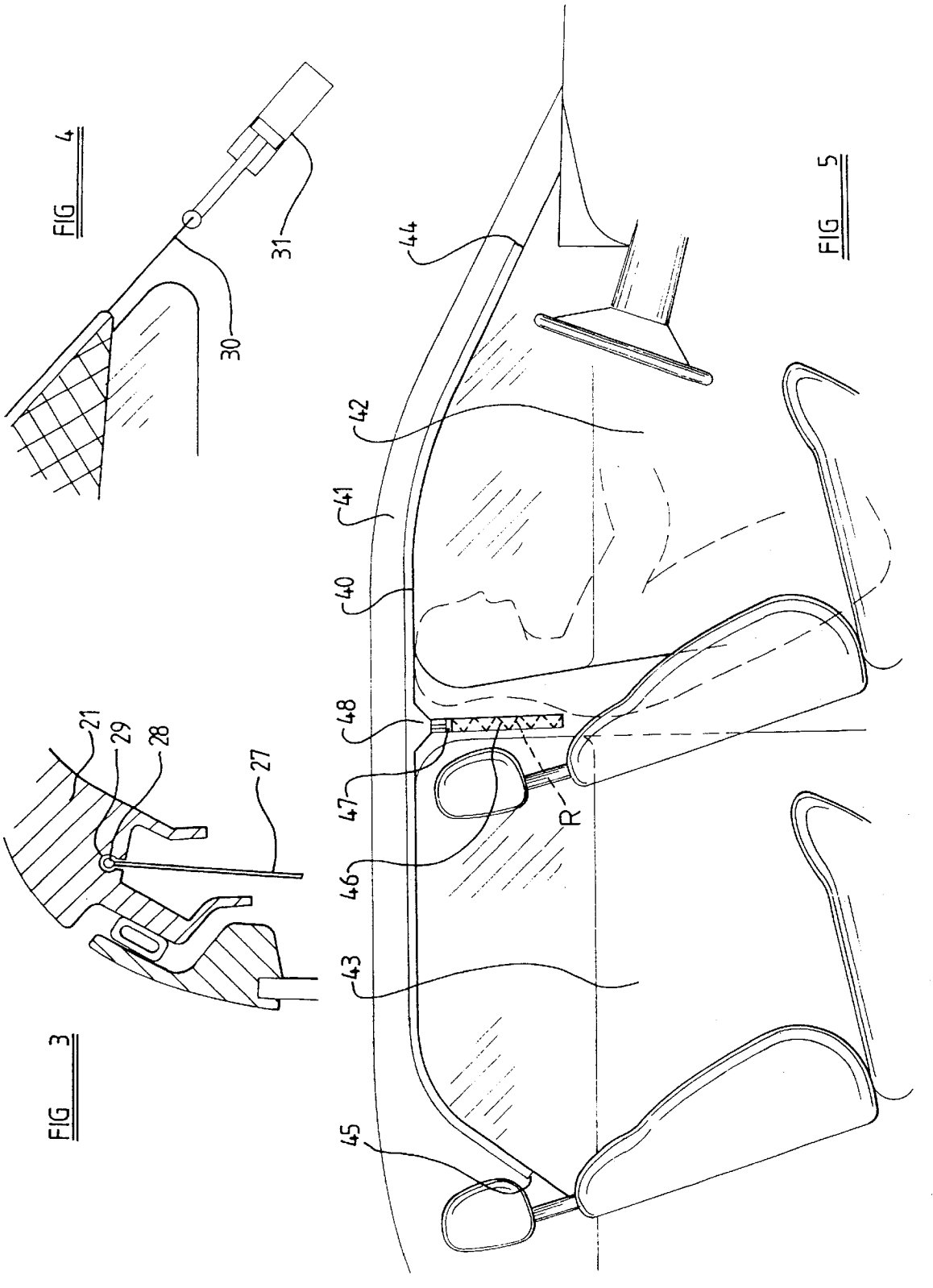


FIG 3

FIG 4

FIG 5

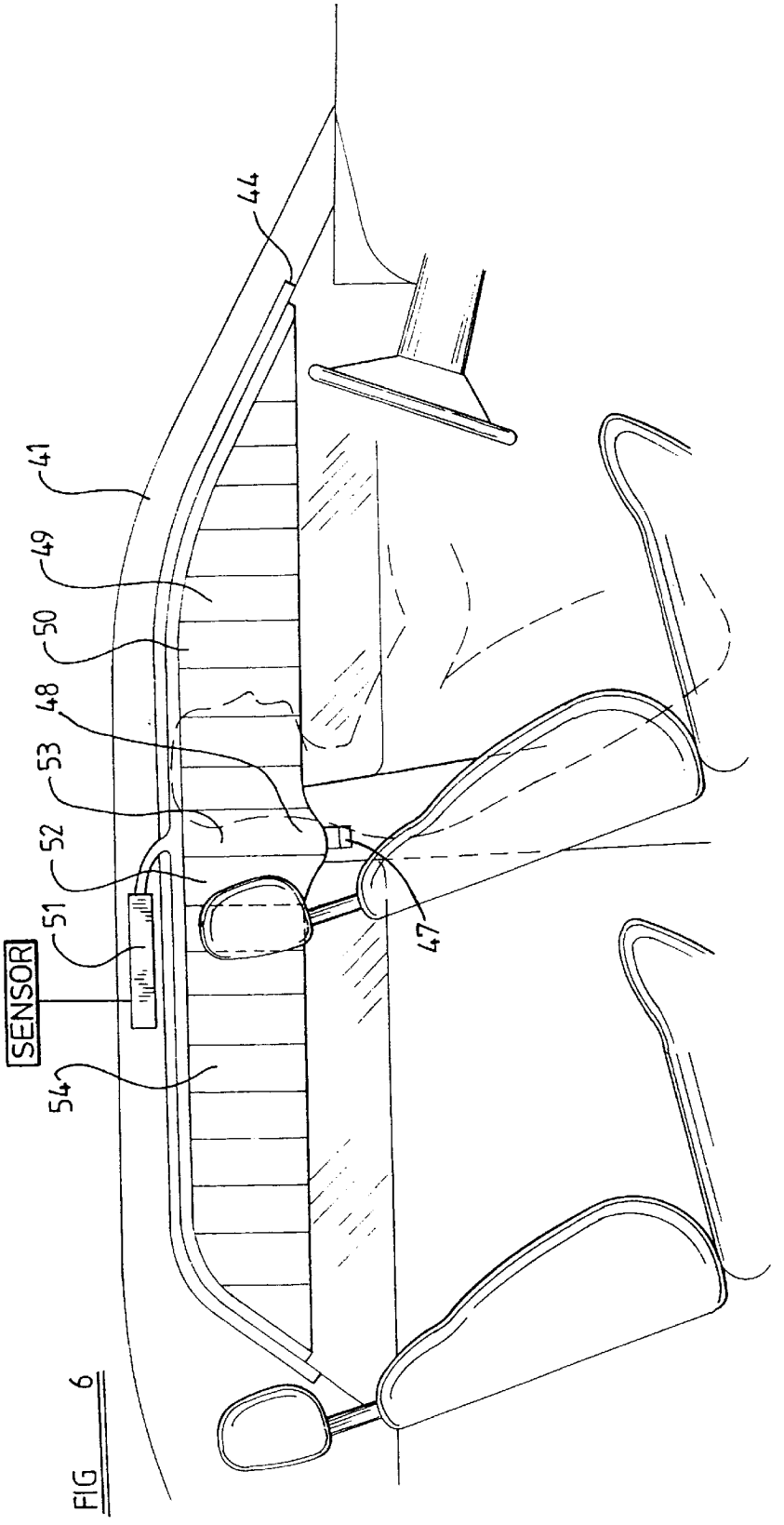


FIG 6

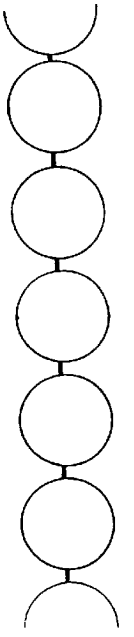


FIG 7

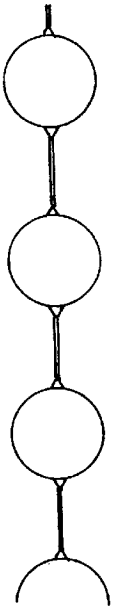


FIG 8

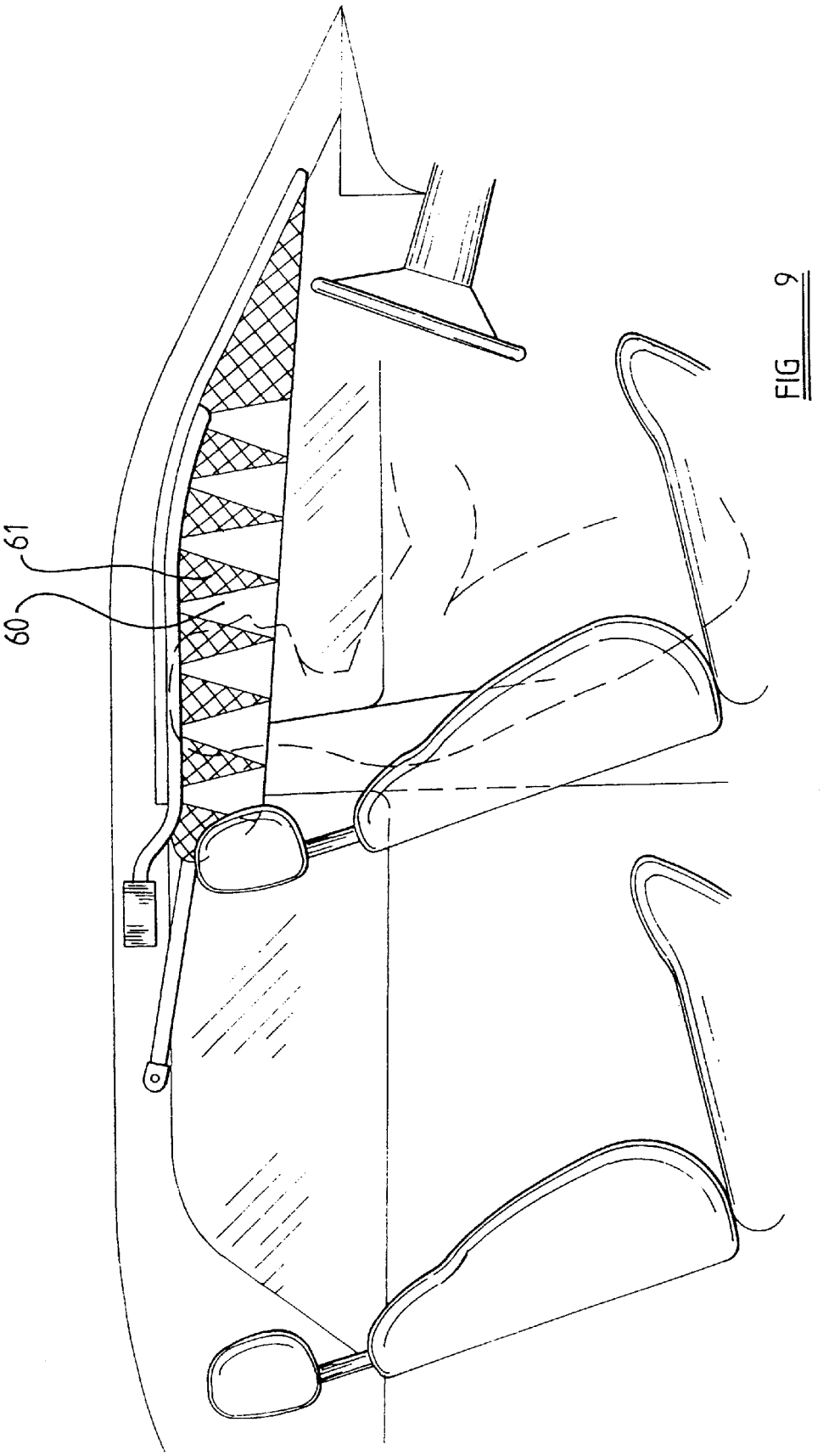


FIG 9

SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 09/964,573 filed Sep. 28, 2001, now U.S. Pat. No. 6,494,480, which is a continuation of U.S. application Ser. No. 09/589,402 filed Jun. 8, 2000, now U.S. Pat. No. 6,312,009, which is a continuation of U.S. application Ser. No. 09/127,918, filed Aug. 3, 1998, now U.S. Pat. No. 6,099,029, which is a continuation of U.S. application Ser. No. 08/604,052, filed Feb. 20, 1996, now U.S. Pat. No. 5,788,274.

FIELD OF THE INVENTION.

THIS INVENTION relates to a safety device, and more particulary relates to a safety device in a motor vehicle such as a motor car.

BACKGROUND OF THE INVENTION

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured. It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. U.S. Pat. No. 5,322,322 discloses such a device. An inflatable tube is initially stored in a recess in the door frame above the door of the vehicle, and the ends of the tube are pivotally anchored to fixed points on the door frame. A sensor is provided to sense when an accident occurs, and to initiate inflation of the tube. As the tube inflates its length decreases, and it then extends linearly between the two fixed points on the door frame. The inflated tube provides some protection for the head of a person sitting in the vehicle. However, the tube is inflated to a substantial pressure, and thus the head of a person in the vehicle may tend to bounce off the tube. The tube may not cover the whole of the area of the window, and may not even cover the whole of the upper part of the window. There is thus a risk that the head of the person in the vehicle may move past the tube and pass through the window opening. If a car is rolling over this is very undesirable.

SUMMARY OF THE INVENTION

This invention seeks to provide an improved safety device.

According to this invention there is provided a safety device in a motor vehicle, the device comprising a gas generator, incorporating or associated with a sensor adapted to sense a side impact or a roll-over and to activate the gas generator, and an inflatable element connected to the gas generator to be inflated by gas from the gas generator, the inflatable element being made of fabric comprising a first layer to define the front part of the inflatable element, and a second layer to define the back part of the inflatable element, selected parts of the first layer and the second layer being interconnected to define points or lines where the front part and back part of the inflatable element are secured together, the inflatable element incorporating a plurality of substantially parallel elongate cells, the inflatable element having an edge portion secured to part of the door frame of the vehicle, which is non-linear, the inflatable element, when inflated, being positioned adjacent the door contained within the door frame.

The inflatable element, when inflated, is thus located between the head of a person sitting in the vehicle and an adjacent door. Usually such a door is provided with a window and so the inflated element provides protection from breaking glass from the window, and also prevents the head of the person in the vehicle from striking the window, or from being thrown out through the window, as can happen, particularly with roll-over accidents.

Preferably the safety device is usually initially stored in a recess provided in the doorframe.

Preferably the inflatable element is made of interwoven fabric layers, the selected parts of the first layer and the second layer being interwoven. Preferably there is internal venting between the cells as this may reduce undesirable bounce that might occur if the cells were discrete and not vented to each other.

The cells may be immediately adjacent each other or may be spaced apart. At least some of the cells may be of conical form when inflated.

The inflatable element may be formed of a fabric with parts of the fabric being interwoven to form the cell or cells. The fabric may have a single layer weight of less than 300 g/sq m, such as a weight of 175 g/sq m.

Preferably when the inflatable element is inflated the pressure of gas is approximately 3 bar. Preferably the inflatable element, when inflated, extends past the B-post of the vehicle, to provide protection for the head of the driver. If the head of the driver should impact with the B-post in an accident the consequences could be fatal.

In one embodiment the inflatable element incorporates a strap to connect part of the inflatable element to the door frame. The strap is tight, that is, tensioned to a significant extent, when the inflatable element is inflated.

Separate means may be provided to apply tension to part of the inflatable element when it is inflated, such as a piston and cylinder, adapted to be moved by gas from a gas generator when the inflatable element is inflated, to apply tension to one edge of the inflatable element, to hold the inflated element in a desired position.

In one embodiment the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain the means in the further position. Thus, a slider may be provided adapted to slide along a ratchet, and to be retained by the ratchet when it has moved to a further position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and so that further features thereof may be appreciated the invention will now be described by way of example with reference to the accompanying drawings in which

FIG. **1** is a side view of the interior of a motor vehicle illustrating a safety device in accordance with the invention in an operative state,

FIG. **2** is a side view of part of the interior of a motor vehicle illustrating another safety device in accordance with the invention in the operative state,

FIG. **3** is a sectional view of part of the embodiment of FIG. **2**, in a plane perpendicular to a longitudinal axis of the vehicle.

FIG. **4** is a view of part of FIG. **2** showing an additional component of the safety device,

FIG. **5** is a side view of the interior of a motor vehicle provided with another form of safety device in accordance

with the invention, before the safety device moves to the operative state,

FIG. **6** illustrates the vehicle of FIG. **5** when the safety device is in the operative state,

FIG. **7** is a sectional view of one form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, in a plane perpendicular to the vertical direction.

FIG. **8** is a sectional view of another form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, and

FIG. **9** is a view of part of an alternative inflatable element for use in the embodiments of FIGS. **1**, **5** and **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1** a safety device is illustrated which is intended to provide protection for a person **1** sitting in a seat **2** in the vehicle. In any accident in which the vehicle is decelerated the person will tend to move forwardly towards the steering wheel **3**, but will be restrained by a conventional seat belt or airbag. In the case of a side impact or roll-over, there is a risk that the head of the person **1** will strike the window in the door beside the person, or strike the B-post. There is also a risk that if, as most commonly happens, the glass in the window should break, the head of the person **1** may be thrown out of the window, especially in the case of roll-over.

The safety device shown in the operative state in FIG. **1** is initially retained in a recess provided in the door frame **4** located above the door of the vehicle. The recess extends over more than simply a linear portion of the door frame so that the two ends of the recess are not in alignment with the main part of the recess.

The safety device comprises a gas generator **5**, which is adapted to generate gas, such as cold gas. The gas generator incorporates, or is associated with, a sensor which senses a side impart and/or a roll-over situation to activate the gas generator at an appropriate instant. The gas generator is connected by a hose **6** to a duct **7**. The duct **7** forms part of an inflatable element. The inflatable element incorporates a plurality of parallel substantially vertical, substantially cylindrical cells **8**. The inflatable element may be made of interwoven fabric. Such a fabric comprises a first layer that defines the front of the inflatable element—that is to say the part that is visible in FIG. **1**—and a second layer that defines the back part-that is to say the part that is adjacent the window in FIG. **1**—selected parts of the first region and the second region being interwoven to define links in the form of points or lines where the front part and the back part of the inflatable element are secured together. A technique for making an inflatable element of interwoven fabric is described in more detail in International Patent Publication WO 90/09295.

A webbing strap **9** that forms part of the inflatable element extends from the end of the inflatable element near the duct **7** which is connected to the hose **6** to an anchoring point **10** on the door frame **4**. The edge of the duct **7** between the points **11**, adjacent the top of the B-post **12**, and **13**, at the lower part of the A-post, in the region of the dashboard **14**, is fixed securely to the door frame **4**. Consequently, it is to be understood that the upper edge of the inflatable element has a non-linear configuration which conforms with the non-linear configuration of the upper part of the door frame **4** by virtue of the inflatable element being secured, at an upper edge portion thereof, to the door frame all along a non-linear part of the door frame as shown in the figures. A substantial part, in fact virtually all, of the upper edge of the inflatable element is secured to the upper part of the door frame.

When an accident such as side impart occurs the gas generator generates cold gas which passes through the hose **6** to the duct **7**, and then inflates the cells **8**. The inflatable element thus moves from its initial stored position within the recess in the door frame to the operative position shown in FIG. **1**. The inflatable element then extends downwardly from the top of the door frame to form a flat structure located between the head of the person **1** and the adjacent window. As the cylindrical cells inflate the length of the lower edge **15** of the inflatable element is reduced, and thus the lower edge, together with the webbing strap **9** extend substantially tightly from the point **10** to the point **13**. It is to be noted that the part of the door frame **4** between the points **10** and **13** is not linear, and defines, with the linear lower edge of the inflated element, a triangular area which is covered by the inflated element.

The lower edge of the inflated element decreases by about 10% between the uninflated state and the inflated state. The inflated element is fully inflated within about 15 ms. The total thickness of the inflated element, when inflated is approximately 30–40 mm. The seams of interweaving of the front part and the back part of the inflated element are approximately 30–40 mm apart, so that the resultant cells are cylindrical when inflated. The total volume of gas within the inflated element may be between 7 and 9 liters, and the gas may be at a pressure of about 3 bar. While the inflated element is not provided with a vent to vent gas from within the element to the atmosphere, so that the inflated element, when inflated, remains inflated for a long period of time—to provide protection in the case of a protracted roll-over—there is venting between at least selected adjacent cells **8**, to avoid any severe rebound. Thus if the head of the person in the vehicle impacts with the inflated element the pressure of gas within the whole element, or at least a substantial part of the element will rise, thus giving a "soft" impact. If each cell were sealed with no venting of this type, there would be a risk of severe rebound.

The weight of the fabric should be kept to be as low as possible, so that if the inflatable element should impact with the head of the person in the vehicle as the inflatable element is inflated no harm will be done. It is thought that a material having a weight of less that 300 g/sq m, such as 175 g/sq m may be used.

It is to be noted that part of the inflated element extends rearwardly beyond the point **11**, and is thus located between the head of the person **1** and the top of the B-post. Thus, the risk of the head of the person impacting with the B-pot is minimized. Since the upper edge of the inflatable element is secured to the upper part of the door frame along substantially the whole of its length, there is virtually no risk that the head of the occupant will pass between the upper edge of the inflatable element and the upper part of the door frame, with the head of the occupant of the vehicle thus inadvertently emerging from the body shell of the vehicle.

FIGS. **2** to **4** illustrate a second embodiment of the invention. In this embodiment an inflatable element **20** is provided which is initially stored in a recess provided in the door frame **21** of a motor vehicle. A gas generator **22** is provided, which again incorporates or is associated with a sensor or detector which activates the gas generator at an appropriate time. The gas generator is connected by a duct **23** to an inflatable part **24** of the inflatable element **20**. The gas generator **22** is located in the door frame **21** of the vehicle, but alternatively could be positioned in the B-post.

The inflatable part **24** or the inflatable section of the inflatable element **20** is formed from two layers of fabric, as

in the embodiment of FIG. **1**, with the front layer and the back layer of the fabric being woven together at selected points **25**. The selected points **25** are arranged in vertically extending columns and serve to divide the inflatable part **24** into a plurality of vertical parallel chambers. The spaces between the selected points **25** permit internal venting between adjacent chambers.

The inflatable part **24** of the inflatable element **20** is adapted to be located adjacent the head of an occupant of the motor vehicle, and, towards the rear of the inflatable element, when in the position illustrated in FIG. **2**, the inflatable part of the inflatable element extends from the top to the bottom of the inflatable element in a rear region and subsequently, the upper edge of the inflatable part extends downwardly towards the lower edge of the inflatable element, in a sense directed towards the A-Post **26**. The remaining part or non-inflatable section of the inflatable element comprises a web or sheet **27** which extends from the inflatable part **24** to the part of the door frame **21** above the door and to the A-post. The web or sheet **27** is thus secured to parts of the door frame that are non-linear. It is to be appreciated, therefore, that in this embodiment of the invention the upper edge of the inflatable element is of non-linear form and is of the same configuration as the non-linear part of the door frame which extends forwardly from the B-post and which incorporates the A-post. The upper edge of the inflatable element, or at least a substantial part of the upper edge, is securely fixed to the upper part of the door frame, thus again minimizing any risk of the head of the occupant emerging from the body shell between the upper edge of the inflatable element and the upper part of the door frame.

Referring to FIG. **3** the edge of the sheet **27** that is secured to the door frame **21** may terminate with a bead **28** that is received within a slot **29** formed in the door frame, the mouth of the slot being narrower than the base so that the bead **28** can slide axially within the slot, but cannot escape from the slot A cable **30** is connected to the end of the bead, as can be seen in FIG. **4**, the cable being connected to a tensioning device **31**. The tensioning device may comprise a piston in a cylinder associated with a gas generator to generate gas which moves the piston within the cylinder to apply tension to the cable **30** and thus to the bead **28**. A ratchet or the like may hold the piston in place when it has been moved by the gas. The gas generator that supplies gas to the piston may be the gas generator **22** or may be a separate gas generator that is triggered simultaneously with the main gas generator

When an accident occurs, the inflatable element **20** moves from its stored position to the operative position shown in FIG. **2**, and tension is applied to the inflatable element **20** by the distention of the inflatable part **24**, and by the tension applied to the bead **28**. The inflated element **20** is thus held firmly in position to provide protection for the head of the person sitting in the motor vehicle. The thickness of the element **20** and the weight of the material used should be as described with reference to the embodiment of FIG. **1**.

FIGS. **5** and **6** illustrate another embodiment of the invention intended to provide protection not only for a person in the front seat of a motor vehicle such as a motor car, but also for a person in the rear seat of the vehicle.

Referring to FIG. **5**, a recess **40** is provided in the doorframe **41** of a motor vehicle, the recess extending over both the front door **42** and the rear door **43**. The recess extends from a point **44** located near the lower end of the A-post to a point **45** located near the lower end of the C-post.

A channel **46** is provided on the B-post, extending vertically. In the channel **46** is a ratchet R, and received within the upper end of the channel **46** is a ratchet engaging slide member **47**. The slide member **47** is connected to a tab **48** which forms part of an inflatable element **49** (see FIG. **6**), which is initially stored within the recess **40**.

The inflatable element **49** is shown in the inflated state in FIG. **6**. The inflatable element has its top edge **50** secured to the part of the door frame **41** that extends above the doors **42**, **43** of the motor vehicle. The top edge of the inflatable element is of non-linear configuration, and has a configuration which corresponds with the non-linear configuration of the upper part of the door frame. The design of the inflatable element is similar to that shown in FIG. **1**, with the inflatable element presenting a plurality of parallel cells, which when inflated are substantially cylindrical. The structure of the inflatable element **49** may be the same as that described with reference to FIG. **1**.

A gas generator **51** is provided which is connected to the inflatable element in such a way that when the gas generator is activated by a sensor that is formed integrally with the gas generator, or which is associated with the gas generator, and which responds to a side impact or to a roll-over situation to activate the gas generator, gas is initially supplied to the cells **52**, **53**, which are aligned with the tab **48**. Thus initially, as the inflatable element **49** inflates, the cells **52** and **53** inflate and move the ratchet engaging slide member **47** downwardly. The ratchet engaging slide member thus moves down the slot **46** to the position shown in FIG. **6**. The ratchet engaging slide member **47** engages the ratchet, and thus holds the tab **48** in its lower position.

The rest of the cells **54** of the inflatable element are then inflated, and the inflatable element then extends fully across the upper parts of the windows in the doors **42**, **43** of the motor vehicle. It can be seen that the lower edge of the inflated element **49** extends between the points **44** and **45** at the ends of the recess **40**. As the inflatable element **49** inflates, so the length of the lower edge thereof decreases as a consequence of the inflation of the cells of the inflatable element. This reduction in the length of the lower edge, together with the action of the ratchet engaging slide member **47** ensures that the inflated element is retained in position as illustrated after it has been inflated.

FIG. **7** is a cross section showing the nature of the cells of the inflated element of FIG. **1** and of FIGS. **5** and **6**. It can be seen that the cells are immediately adjacent to each other and are only separated by narrow regions where the fabric forming the front part of the inflated element has been woven with the fabric forming the back part of the inflated element. However, FIG. **8** illustrates an alternative possibility, in which the regions of fabric between the cells that are woven together are relatively wide, the cells thus being separated by webs of fabric. The advantage of this latter possibility is that a smaller volume of gas may be required to fully inflate the inflatable element, meaning that the inflatable element may be inflated more rapidly.

FIG. **9** illustrated an alternative form of inflatable element comprising a plurality of cells **60** or inflatable sections. The upper edge of the inflatable element is of non-linear form and is connected to the non-linear portion of the door frame above the door. The configuration of the upper edge of the inflatable element and the configuration of the door frame correspond. It can be seen that each cell **60** is of substantially conical form, the cells being arranged adjacent each other and being parallel with each other. Between the cells are inverted triangular portions **61** or non-inflatable sections where the fabric forming the cells is interwoven.

When cells of this type are inflated, the length of the lower edge of the arrangement contracts, whereas the length of the upper edge of the arrangement remains constant.

An arrangement of this type can be used, therefore, to ensure that the lower edge of the element, when inflated, is under some tension.

Whilst in the arrangement illustrated in FIG. **9**, the cells are immediately adjacent each other, it is to be appreciated that a similar effect may be achieved if the cells are spaced apart. It is possible to replace at least part of the inverted triangular region **61** with further conical cells of an inverted orientation.

While in the described embodiments of the invention the inflatable element has been described as being made utilising a technique in which two layers of fabric are interwoven to define points or lines where the front layer and the rear layer are interwoven, it would be possible to form embodiments of the invention utilising two discrete layers of fabric which are interconnected by stitching.

What is claimed is:

1. A safety device in a motor vehicle having a door frame with a front door and a rear door comprising:

a gas generator;

a sensor associated with said gas generator for sensing at least one of a side impact and a roll-over to activate said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element having an upper edge portion with a duct through which the gas flows and comprising a first layer of fabric and a second layer of fabric where selected parts of the first layer and the second layer are interconnected to define one of points and lines so that the first and second layers of said inflatable element are secured together forming elongated cells;

where the upper edge portion of said inflatable element is secured from a first end to a second end at selected points to a non-linear part of the door frame, which extends over both the front and rear doors, and

where said gas generator is positioned between the first and second ends of said upper edge portion of said inflatable element.

2. A safety device according to claim **1**, wherein said gas generator is located substantially in the center of said upper edge portion of said inflatable element.

3. A safety device according to claim **1**, wherein the duct of said upper edge portion is arranged so that gas is initially supplied to elongated cells substantially m the center of said inflatable element after said sensor activates said gas generator thereby inflating the center elongated cells first.

4. A safety device according to claim **1**, wherein the one of points and lines interconnecting the first and second layers of said inflatable element form adjacent elongated cells separated by narrow regions.

5. A safety device according to claim **1**, wherein the one of points and lines interconnecting the first and second layers of said inflatable element form elongated cells separated by webs of fabric.

6. A safety device according to claim **1**, further comprising an A-post located in front of the front door and a C-post located behind the rear door wherein said inflatable element extends from the A-post to the C-post.

* * * * *

Exhibit D

US006494480B2

(12) **United States Patent**
Håland et al.

(10) **Patent No.: US 6,494,480 B2**
(45) **Date of Patent: *Dec. 17, 2002**

(54) **SIDE IMPACT ROLL OVER INFLATABLE HEAD PROTECTOR**

(75) Inventors: **Yngve Håland**, Falsterbo (SE); **Lars-Erik Florberger**, Lidköping (SE); **Sture Andersson**, Nacka (SE); **Simomn Valkenburg**, Macclesfield (GB); **I. Jörgen Svensson**, Saltsjö-Boo (SE)

(73) Assignee: **Autoliv Development AB**, Vargarda (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/964,573**

(22) Filed: **Sep. 28, 2001**

(65) **Prior Publication Data**

US 2002/0008371 A1 Jan. 24, 2002

Related U.S. Application Data

(63) Continuation of application No. 09/589,402, filed on Jun. 8, 2000, now Pat. No. 6,312,009, which is a continuation of application No. 09/127,918, filed on Aug. 3, 1998, now Pat. No. 6,099,029, which is a continuation of application No. 08/604,052, filed on Feb. 20, 1996, now Pat. No. 5,788,270.

(30) **Foreign Application Priority Data**

Feb. 20, 1995 (GB) 9503267

(51) **Int. Cl.**[7] **B60R 21/22**; B60R 21/24

(52) **U.S. Cl.** **280/729**; 280/730.2

(58) **Field of Search** 280/730.2, 730.1, 280/729, 743.1, 743.2, 728.1, 753, 749

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,731,949 A	5/1973	Radke	
3,792,873 A	2/1974	Buchner et al.	
3,897,961 A	8/1975	Leising et al.	
4,227,717 A	10/1980	Bouvier	
5,322,322 A	6/1994	Bark et al.	
5,333,899 A	8/1994	Witte	
5,588,672 A	12/1996	Karlow et al.	

FOREIGN PATENT DOCUMENTS

DE	2222621	11/1972
DE	4134995	3/1993
DE	4307175	9/1993
DE	4231522	3/1994

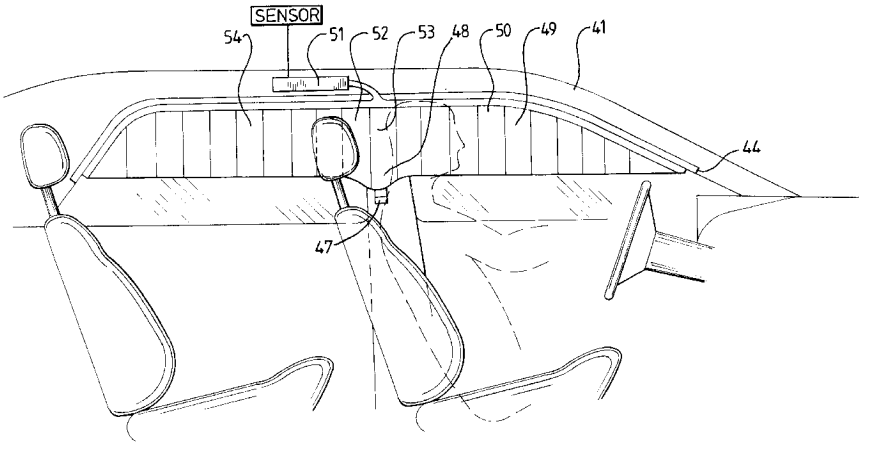
(List continued on next page.)

Primary Examiner—Peter C. English
(74) *Attorney, Agent, or Firm*—Venable; Catherine M. Voorhees

(57) **ABSTRACT**

A safety device for a motor vehicle which has a door frame and a door contained within the door frame. The safety device includes: a gas generator; a sensor for sensing at least one of a side impact and a roll-over for activating the gas generator; and an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator. The inflatable element can thus assume a non-inflated mode and an inflated mode and can further be positioned adjacent the door in an inflated-mode thereof The inflatable element is further made of fabric and includes: a first fabric layer defining a front part thereof, a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together. The inflatable element thus incorporates a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned. The inflatable element further includes an upper edge portion which is configured to be secured to the door frame all along a non-linear part of the door frame.

17 Claims, 5 Drawing Sheets



FOREIGN PATENT DOCUMENTS

EP	0584781	3/1994
EP	0590518	4/1994
GB	962946	7/1964
GB	2191450	12/1987
GB	2261636	5/1993
GB	2278812	12/1994
JP	5-131889	5/1993
WO	90/09295	8/1990
WO	94/19215	9/1994

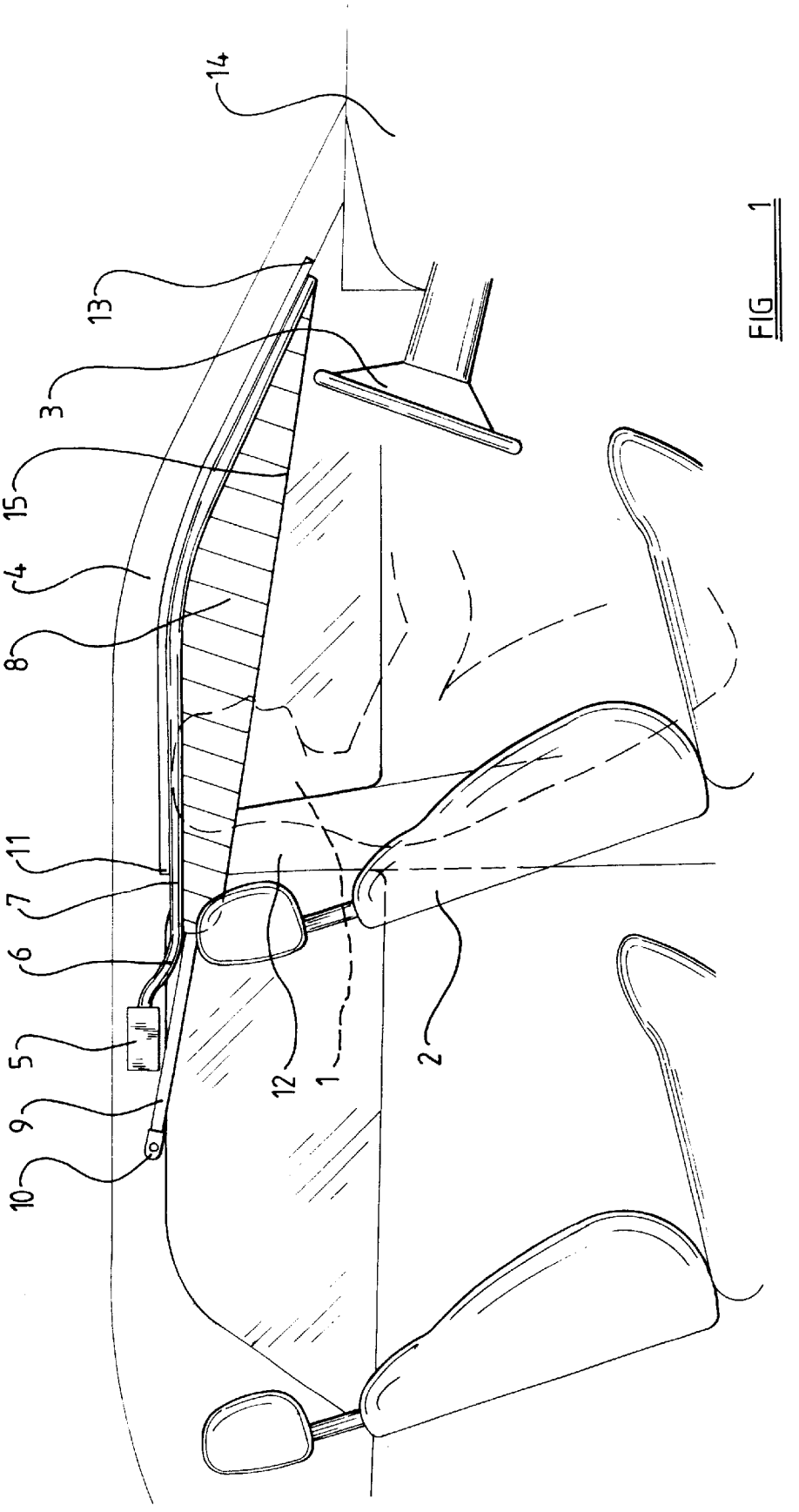


FIG 1

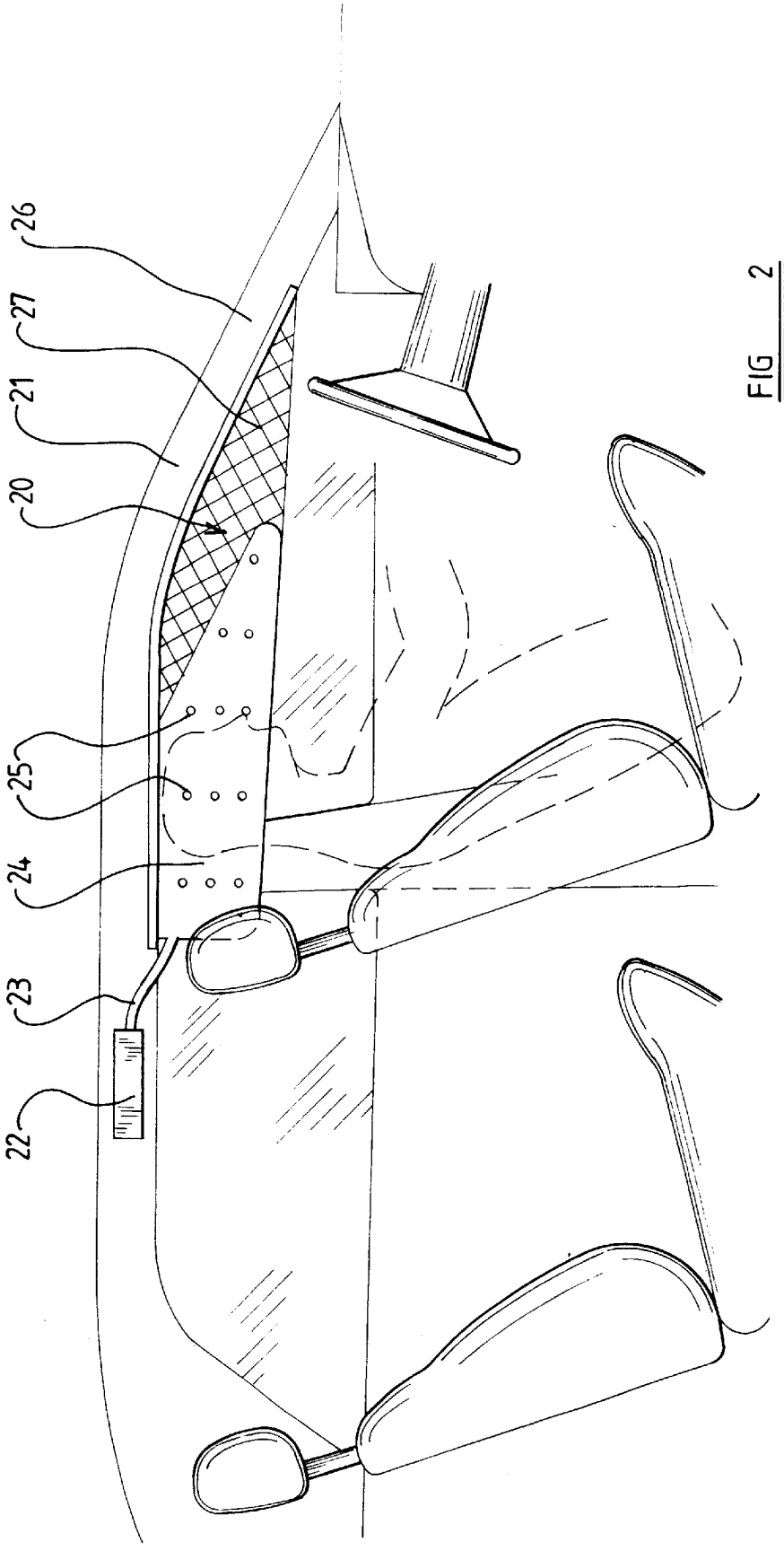


FIG 2

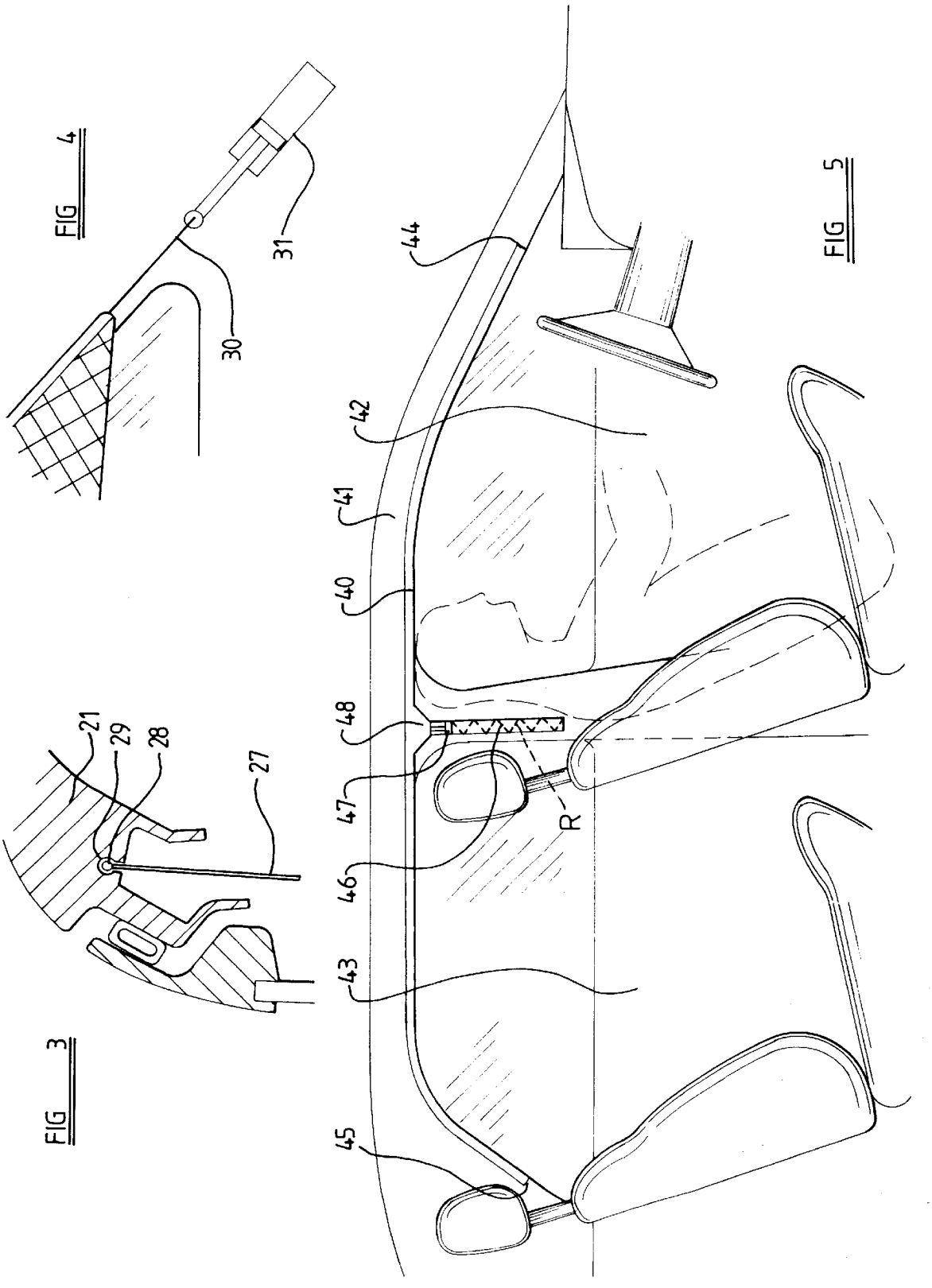


FIG 4
31
30
FIG 5
44
42
41
40
48
47
46
43
45
R
FIG 3
21
29
28
27

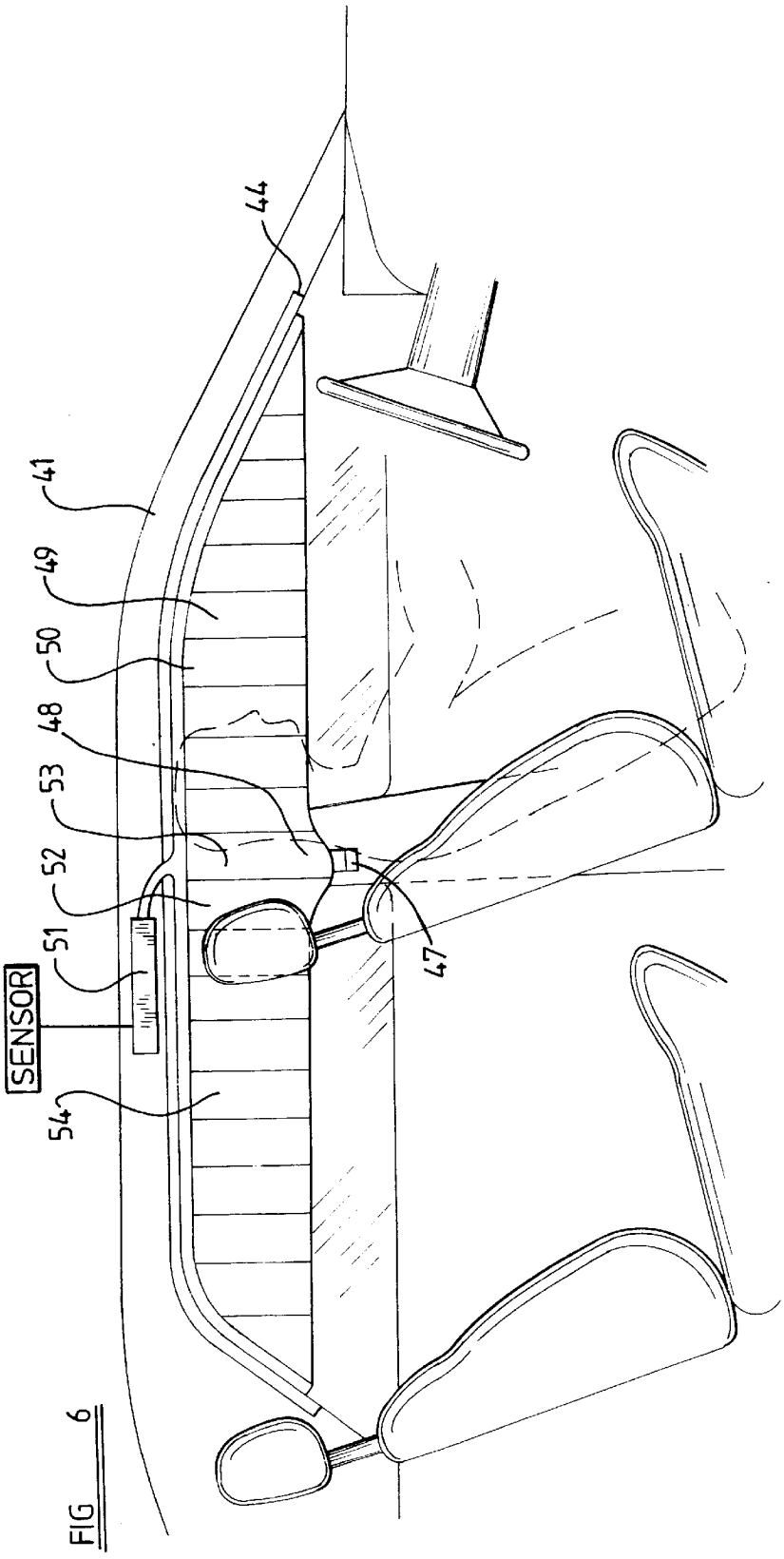


FIG 6

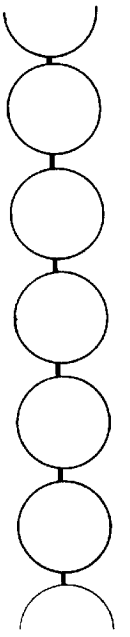


FIG 7

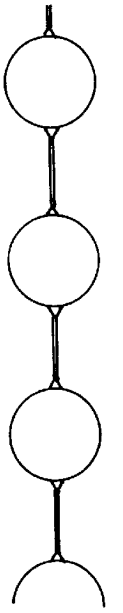


FIG 8

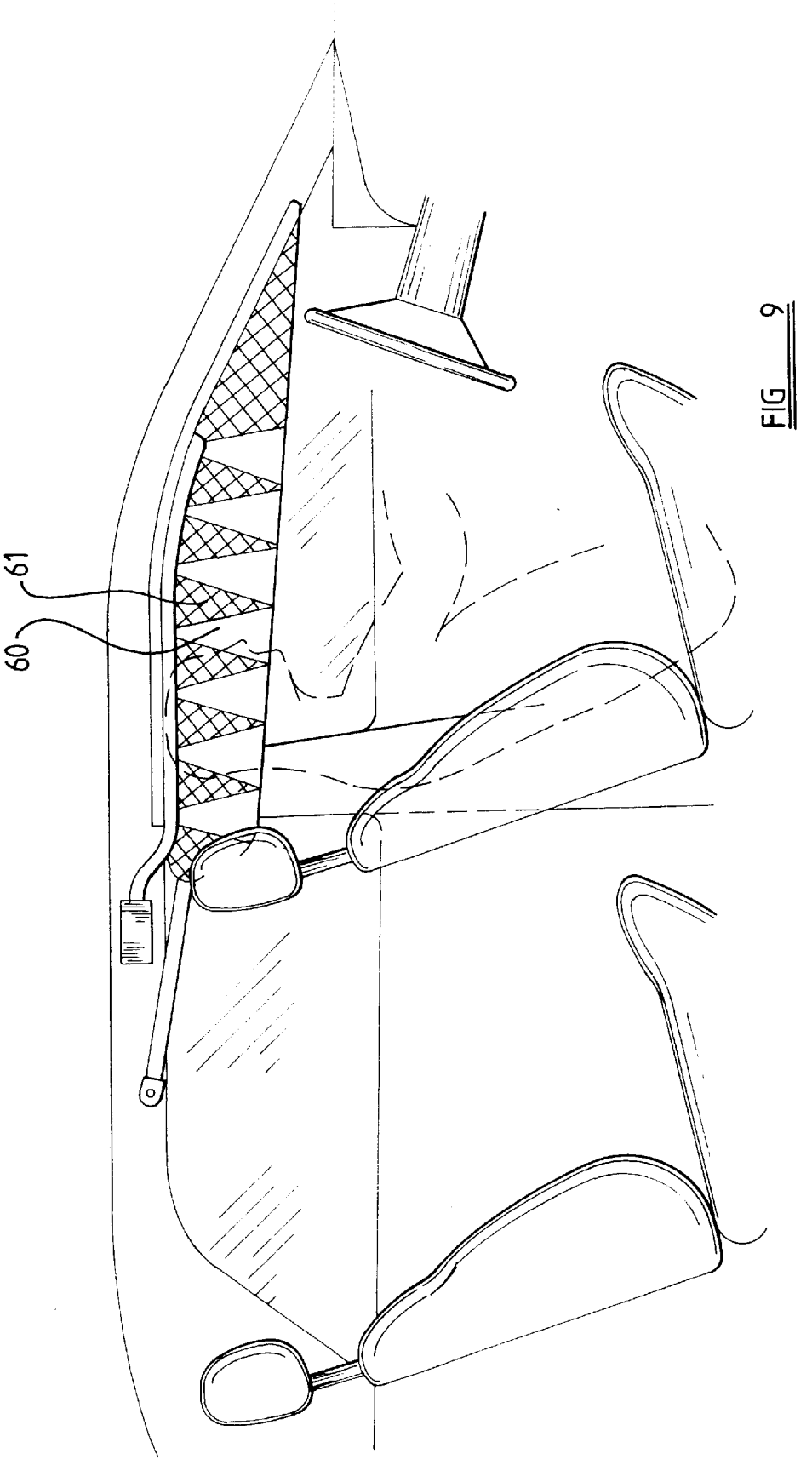


FIG 9

SIDE IMPACT ROLL OVER INFLATABLE HEAD PROTECTOR

SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR

This application is a continuation of U.S. application Ser. No. 09/589,402 filed Jun. 8, 2000, now U.S. Pat. No. 6,312,009 which is a continuation of U.S. application Ser. No. 09/127, 918, filed Aug. 3, 1998, now U.S. Pat. No. 6,099,029 which is a continuation of U.S. application Ser. No. 08/604,052, filed Feb. 20, 1996, now U.S. Pat. No. 5,788,270.

FIELD OF THE INVENTION

THIS INVENTION relates to a safety device, and more particularly relates to a safety device in a motor vehicle such as a motor car.

BACKGROUND OF THE INVENTION

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured. It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. U.S. Pat. No. 5,322,322 discloses such a device. An inflatable tube is initially stored in a recess in the door frame above the door of the vehicle, and the ends of the tube are pivotally anchored to fixed points on the door frame. A sensor is provided to sense when an accident occurs, and to initiate inflation of the tube. As the tube inflates its length decreases, and it then extends linearly between the two fixed points on the door frame. The inflated tube provides some protection for the head of a person sitting in the vehicle However, the tube is inflated to a substantial pressure, and thus the head of a person in the vehicle may tend to bounce off the tube. The tube may not cover the whole of the area of the window, and may not even cover the whole of the upper part of the window. There is thus a risk that the head of the person in the vehicle may move past the tube and pass through the window opening. If a car is rolling over this is very undesirable.

SUMMARY OF THE INVENTION

This invention seeks to provide an improved safety device.

According to this invention there is provided a safety device in a motor vehicle, the device comprising a gas generator, incorporating or associated with a sensor adapted to sense a side impact or a roll-over and to activate the gas generator, and an inflatable element connected to the gas generator to be inflated by gas from the gas generator, the inflatable element being made of fabric comprising a first layer to define the front part of the inflatable element, and a second layer to define the back part of the inflatable element, selected parts of the first layer and the second layer being interconnected to define points or lines where the front part and back part of the inflatable element are secured together, the inflatable element incorporating a plurality of substantially parallel elongate cells, the inflatable element having an edge portion secured to part of the door frame of the vehicle, which is non-linear, the inflatable element, when inflated, being positioned adjacent the door contained within the door frame.

The inflatable element, when inflated, is thus located between the head of a person sitting in the vehicle and an adjacent door. Usually such a door is provided with a window and so the inflated element provides protection from breaking glass from the window, and also prevents the head of the person in the vehicle from striking the window, or from being thrown out through the window, as can happen, particularly with roll-over accidents.

Preferably the safety device is usually initially stored in a recess provided in the doorframe.

Preferably the inflatable element is made of interwoven fabric layers, the selected parts of the first layer and the second layer being interwoven. Preferably there is internal venting between the cells as this may reduce undesirable bounce that might occur if the cells were discrete and not vented to each other.

The cells may be immediately adjacent each other or may be spaced apart. At least some of the cells may be of conical form when inflated.

The inflatable element may be formed of a fabric with parts of the fabric being interwoven to form the cell or cells. The fabric may have a single layer weight of less than 300 g/sq m, such as a weight of 175 g/sq m.

Preferably when the inflatable element is inflated the pressure of gas is approximately 3 bar. Preferably the inflatable element, when inflated, extends past the B-post of the vehicle, to provide protection for the head of the driver. If the head of the driver should impact with the B-post in an accident the consequences could be fatal.

In one embodiment the inflatable element incorporates a strap to connect part of the inflatable element to the door frame. The strap is tight, that is, tensioned to a significant extent, when the inflatable element is inflated.

Separate means may be provided to apply tension to part of the inflatable element when it is inflated, such as a piston and cylinder, adapted to be moved by gas from a gas generator when the inflatable element is inflated, to apply tension to one edge of the inflatable element, to hold the inflated element in a desired position.

In one embodiment the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain the means in the further position. Thus, a slider may be provided adapted to slide along a ratchet, and to be retained by the ratchet when it has moved to a further position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and so that further features thereof may be appreciated the invention will now be described by way of example with reference to the accompanying drawings in which

FIG. **1** is a side view of the interior of a motor vehicle illustrating a safety device in accordance with the invention in an operative state,

FIG. **2** is a side view of part of the interior of a motor vehicle illustrating another safety device in accordance with the invention in the operative state,

FIG. **3** is a sectional view of part of the embodiment of FIG. **2**, in a plane perpendicular to a longitudinal axis of the vehicle.

FIG. **4** is a view of part of FIG. **2** showing an additional component of the safety device,

FIG. **5** is a side view of the interior of a motor vehicle provided with another form of safety device in accordance with the invention, before the safety device moves to the operative state,

FIG. **6** illustrates the vehicle of FIG. **5** when the safety device is in the operative state,

FIG. **7** is a sectional view of one form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, in a plane perpendicular to the vertical direction.

FIG. **8** is a sectional view of another form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, and

FIG. **9** is a view of part of an alternative inflatable element for use in the embodiments of FIGS. **1**, **5** and **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1** a safety device is illustrated which is intended to provide protection for a person **1** sitting in a seat **2** in the vehicle. In any accident in which the vehicle is decelerated the person will tend to move forwardly towards the steering wheel **3**, but will be restrained by a conventional seat belt or air-bag. In the case of a side impact or roll-over, there is a risk that the head of the person **1** will strike the window in the door beside the person, or strike the B-post. There is also a risk that if, as most commonly happens, the glass in the window should break, the head of the person **1** may be thrown out of the window, especially in the case of roll-over.

The safety device shown in the operative state in FIG. **1** is initially retained in a recess provided in the door frame **4** located above the door of the vehicle. The recess extends over more than simply a linear portion of the door frame so that the two ends of the recess are not in alignment with the main part of the recess.

The safety device comprises a gas generator **5**, which is adapted to generate gas, such as cold gas. The gas generator incorporates, or is associated with, a sensor which senses a side impart and/or a roll-over situation to activate the gas generator at an appropriate instant. The gas generator is connected by a hose **6** to a duct **7**. The duct **7** forms part of an inflatable element. The inflatable element incorporates a plurality of parallel substantially vertical, substantially cylindrical cells **8**. The inflatable element may be made of interwoven fabric. Such a fabric comprises a first layer that defines the front of the inflatable element-that is to say the part that is visible in FIG. **1**-and a second layer that defines the back part-that is to say the part that is adjacent the window in FIG. **1**-selected parts of the first region and the second region being interwoven to define links in the form of points or lines where the front part and the back part of the inflatable element are secured together. A technique for making an inflatable element of interwoven fabric is described in more detail in International Patent Publication WO 90/09295.

A webbing strap **9** that forms part of the inflatable element extends from the end of the inflatable element near the duct **7** which is connected to the hose **6** to an anchoring point **10** on the door frame **4**. The edge of the duct **7** between the points **11**, adjacent the top of the B-post **12**, and **13**, at the lower part of the A-post, in the region of the dashboard **14**, is fixed securely to the door frame **4**. Consequently, it is to be understood that the upper edge of the inflatable element has a non-linear configuration which conforms with the non-linear configuration of the upper part of the door frame **4** by virtue of the inflatable element being secured, at an upper edge portion thereof, to the door frame all along a non-linear part of the door frame as shown in the figures. A substantial part, in fact virtually all, of the upper edge of the inflatable element is secured to the upper part of the door frame.

When an accident such as side impart occurs the gas generator generates cold gas which passes through the hose **6** to the duct **7**, and then inflates the cells **8**. The inflatable element thus moves from its initial stored position within the recess in the door frame to the operative position shown in FIG. **1**. The inflatable element then extends downwardly from the top of the door frame to form a flat structure located between the head of the person **1** and the adjacent window. As the cylindrical cells inflate the length of the lower edge **15** of the inflatable element is reduced, and thus the lower edge, together with the webbing strap **9** extend substantially tightly from the point **10** to the point **13**. It is to be noted that the part of the door frame **4** between the points **10** and **13** is not linear, and defines, with the linear lower edge of the inflated element, a triangular area which is covered by the inflated element.

The lower edge of the inflated element decreases by about 10% between the uninflated state and the inflated state. The inflated element is fully inflated within about 15 ms. The total thickness of the inflated element, when inflated is approximately 30–40 mm. The seams of interweaving of the front part and the back part of the inflated element are approximately 30–40 mm apart, so that the resultant cells are cylindrical when inflated. The total volume of gas within the inflated element may be between 7 and 9 liters, and the gas may be at a pressure of about 3 bar. While the inflated element is not provided with a vent to vent gas from within the element to the atmosphere, so that the inflated element, when inflated, remains inflated for a long period of time—to provide protection in the case of a protracted roll-over—there is venting between at least selected adjacent cells **8**, to avoid any severe rebound. Thus if the head of the person in the vehicle impacts with the inflated element the pressure of gas within the whole element, or at least a substantial part of the element will rise, thus giving a "soft" impact. If each cell were sealed with no venting of this type, there would be a risk of severe rebound.

The weight of the fabric should be kept to be as low as possible, so that if the inflatable element should impact with the head of the person in the vehicle as the inflatable element is inflated no harm will be done. It is thought that a material having a weight of less that 300 g/sq m, such as 175 g/sq m may be used.

It is to be noted that part of the inflated element extends rearwardly beyond the point **11**, and is thus located between the head of the person **1** and the top of the B-post. Thus the risk of the head of the person impacting with the B-pot is minimized. Since the upper edge of the inflatable element is secured to the upper part of the door frame along substantially the whole of its length, there is virtually no risk that the head of the occupant will pass between the upper edge of the inflatable element and the upper part of the door frame, with the head of the occupant of the vehicle thus inadvertently emerging from the body shell of the vehicle.

FIGS. **2** to **4** illustrate a second embodiment of the invention. In this embodiment an inflatable element **20** is provided which is initially stored in a recess provided in the door frame **21** of a motor vehicle. A gas generator **22** is provided, which again incorporates or is associated with a sensor or detector which activates the gas generator at an appropriate time. The gas generator is connected by a duct **23** to an inflatable part **24** of the inflatable element **20**. The gas generator **22** is located in the door frame **21** of the vehicle, but alternatively could be positioned in the B-post.

The inflatable part **24** or the inflatable section of the inflatable element **20** is formed from two layers of fabric, as

in the embodiment of FIG. **1**, with the front layer and the back layer of the fabric being woven together at selected points **25**. The selected points **25** are arranged in vertically extending columns and serve to divide the inflatable part **24** into a plurality of vertical parallel chambers. The spaces between the selected points **25** permit internal venting between adjacent chambers.

The inflatable part **24** of the inflatable element **20** is adapted to be located adjacent the head of an occupant of the motor vehicle, and, towards the rear of the inflatable element, when in the position illustrated in FIG. **2**, the inflatable part of the inflatable element extends from the top to the bottom of the inflatable element in a rear region and subsequently, the upper edge of the inflatable part extends downwardly towards the lower edge of the inflatable element, in a sense directed towards the A-Post **26**. The remaining part or non-inflatable inflatable section of the inflatable element comprises a web or sheet **27** which extends from the inflatable part **24** to the part of the door frame **21** above the door and to the A-post. The web or sheet **27** is thus secured to parts of the door frame that are non-linear. It is to be appreciated, therefore, that in this embodiment of the invention the upper edge of the a inflatable element is of non-linear form and is of the same configuration as the non-linear part of the door frame which extends forwardly from the B-post and which incorporates the A-post. The upper edge of the inflatable element, or at least a substantial part of the upper edge, is securely fixed to the upper part of the door frame, thus again minimizing any risk of the head of the occupant emerging from the body shell between the upper edge of the inflatable element and the upper part of the door frame.

Referring to FIG. **3** the edge of the sheet **27** that is secured to the door frame **21** may terminate with a bead **28** that is received within a slot **29** formed in the door frame, the mouth of the slot being narrower than the base so that the bead **28** can slide axially within the slot, but cannot escape from the slot. A cable **30** is connected to the end of the bead, as can be seen in FIG. **4**, the cable being connected to a tensioning device **31**. The tensioning device may comprise a piston in a cylinder associated with a gas generator to generate gas which moves the piston within the cylinder to apply tension to the cable **30** and **42** thus to the bead **28**. A ratchet or the like may hold the piston in place when it has been moved by the gas. The gas generator that supplies gas to the piston may be the gas generator **22** or may be a separate gas generator that is triggered simultaneously with the main gas generator.

When an accident occurs the inflatable element **20** moves from its stored position to the operative position shown in FIG. **2**, and tension is applied to the inflatable element **20** by the distention of the inflatable part **24**, and by the tension applied to the bead **28**. The inflated element **20** is thus held firmly in position to provide protection for the head of the person sitting in the motor vehicle. The thickness of the element **20** and the weight of the material used should be as described with reference to the embodiment of FIG. **1**.

FIGS. **5** and **6** illustrate another embodiment of the invention intended to provide protection not only for a person in the front seat of a motor vehicle such as a motor car, but also for a person in the rear seat of the vehicle.

Referring to FIG. **5**, a recess **40** is provided in the doorframe **41** of a motor vehicle, the recess extending over both the front door **42** and the rear door **43**. The recess extends from a point **44** located near the lower end of the A-post to a point **45** located near the lower end of the C-post.

A channel **46** is provided on the B-post, extending vertically. In the channel **46** is a ratchet R, and received within the upper end of the channel **46** is a ratchet engaging slide member **47**. The slide member **47** is connected to a tab **48** which forms part of an inflatable element **49** (see FIG. **6**), which is initially stored within the recess **40**.

The inflatable element **49** is shown in the inflated state in FIG. **6**. The inflatable element has its top edge **50** secured to the part of the door frame **41** that extends above the doors **42**, **43** of the motor vehicle. The top edge of the inflatable element is of non-linear configuration, and has a configuration which corresponds with the non-linear configuration of the upper part of the door frame. The design of the inflatable element is similar to that shown in FIG. **1**, with the inflatable element presenting a plurality of parallel cells, which when inflated are substantially cylindrical. The structure of the inflatable element **49** may be the same as that described with reference to FIG. **1**.

A gas generator **51** is provided which is connected to the inflatable element in such a way that when the gas generator is activated by a sensor that is formed integrally with the gas generator, or which is associated with the gas generator, and which responds to a side impact or to a roll-over situation to activate the gas generator, gas is initially supplied to the cells **52**, **53**, which are aligned with the tab **48**. Thus initially, as the inflatable element **49** inflates, the cells **52** and **53** inflate and move the ratchet engaging slide member **47** downwardly. The ratchet engaging slide member thus moves down the slot **46** to the position shown in FIG. **6**. The ratchet engaging slide member **47** engages the ratchet, and thus holds the tab **48** in its lower position.

The rest of the cells **54** of the inflatable element are then inflated, and the inflatable element then extends fully across the upper parts of the windows in the doors **42**, **43** of the motor vehicle. It can be seen that the lower edge of the inflated element **49** extends between the points **44** and **45** at the ends of the recess **40**. As the inflatable element **49** inflates, so the length of the lower edge thereof decreases as a consequence of the inflation of the cells of the inflatable element. This reduction in the length of the lower edge, together with the action of the ratchet engaging slide member **47** ensures that the inflated element is retained in position as illustrated after it has been inflated.

FIG. **7** is a cross section showing the nature of the cells of the inflated element of FIG. **1** and of FIGS. **5** and **6**. It can be seen that the cells are immediately adjacent to each other and are only separated by narrow regions where the fabric forming the front part of the inflated element has been woven with the fabric forming the back part of the inflated element. However, FIG. **8** illustrates an alternative possibility, in which the regions of fabric between the cells that are woven together are relatively wide, the cells thus being separated by webs of fabric. The advantage of this latter possibility is that a smaller volume of gas may be required to fully inflate the inflatable element, meaning that the inflatable element may be inflated more rapidly.

FIG. **9** illustrates form of inflatable element comprising a plurality of cells **60** or inflatable sections. The upper edge of the inflatable element is of non-linear form and is connected to the non-linear portion of the door frame above the door. The configuration of the upper edge of the inflatable element and the configuration of the door frame correspond. It can be seen that each cell **60** is of substantially conical form, the cells being arranged adjacent each other and being parallel with each other. Between the cells are inverted triangular portions **61** or non-inflatable sections where the fabric forming the cells is interwoven.

When cells of this type are inflated, the length of the lower edge of the arrangement contracts, whereas the length of the upper edge of the arrangement remains constant.

An arrangement of this type can be used, therefore, to ensure that the lower edge of the element, when inflated, is under some tension.

Whilst in the arrangement illustrated in FIG. **9**, the cells are immediately adjacent each other, it is to be appreciated that a similar effect may be achieved if the cells are spaced apart. It is possible to replace at least part of the inverted triangular region **61** with further conical cells of an inverted orientation.

Whilst in the described embodiments of the invention the inflatable element has been described as being made utilising a technique in which two layers of fabric are interwoven to define points or lines where the front layer and the rear layer are interwoven, it would be possible to form embodiments of the invention utilising two discrete layers of fabric which are interconnected by stitching.

What is claimed is:

1. A safety device in a motor vehicle having a door frame and front and rear doors contained within the door frame, the safety device comprising:

a gas generator;

a sensor associated with said gas generator for sensing one of a side impact and a roll-over and activating said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected to define points where the front part and the back part of said inflatable element are secured together forming elongated cells; and

an upper edge portion secured at selected points to a non-linear part of the door frame which extends over both the front door and the rear door, whereby, when inflated, said inflatable element is positioned adjacent the doors contained in the door frame.

2. A safety device according to claim **1**, wherein said inflatable element is made of fabric and said first and second layers are first and second fabric layers.

3. A safety device in a motor vehicle having a door frame and front and rear doors contained within the door frame, the safety device comprising:

a gas generator;

a sensor associated with said gas generator for sensing one of a side impact and a roll-over and activating said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected to define points where the front part and the back part of said inflatable element are secured together forming substantially vertical cells; and

an upper edge portion secured at selected points to a non-linear part of the door frame which extends over both the front door and the rear door, whereby, when inflated, said inflatable element is positioned adjacent the doors contained in the door frame.

4. A safety device in a motor vehicle having a door frame with an opening comprising:

a gas generator;

a sensor associated with said gas generator for sensing at least one of a side impact and a roll-over that activates said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected to define regions where the front part and the back part of said inflatable element are secured together forming elongated cells which define axes;

a lower edge portion having opposed ends, the opposed ends of the lower edge portion being secured to two fixed anchoring points on the vehicle; and

an upper edge portion secured at at least one selected point to a part of the vehicle at a level above the opening within the door frame, where the axes defined by the cells intersect said lower edge portion of the inflatable element, and

whereby, when inflated, said inflatable element is positioned adjacent a window of a door contained in the opening of the frame, and said cells are designed such that on inflation of the inflatable element, the lower edge portion of said inflatable element is tensioned between the two fixed anchoring points.

5. A safety device according to claim **4**, wherein the inflatable element, in a non-inflated mode, is initially stored in a recess provided in the door frame.

6. A safety device according to claim **4**, wherein said inflatable element is made of fabric and said first and second layers are first and second fabric layers.

7. A safety device according to claim **6**, wherein the first fabric layer and the second fabric layer are interconnected at the selected parts thereof by being interwoven with one another at said regions.

8. A safety device according to claim **4**, wherein the cells are configured to be in gas flow communication with one another.

9. A safety device according to claim **4**, wherein the cells are immediately adjacent each other.

10. A safety device according to claim **4**, wherein the cells are spaced apart from each other.

11. A safety device according to claim **4**, wherein at least some of the cells have a conical shape when the inflatable element is inflated.

12. A safety device according to claim **4**, wherein the inflatable element is made of a fabric having a single layer weight of less than 300 g/sq m.

13. A safety device according to claim **4**, wherein, when inflated, the pressure in the inflatable element is approximately 3 bar.

14. A safety device according to claim **4** wherein the inflatable element, when inflated, extends past a B-post of the vehicle.

15. A safety device according to claim **4**, further comprising a strap connected to a part of the inflatable element and to the door frame.

16. A safety device according to claim **4**, further comprising a tensioning device for applying tension to the inflatable element when it is inflated.

17. The safety device according to claim **4**, wherein the cells are configured to extend substantially. from the upper edge portion of the inflatable element to a lower edge portion of the inflatable element.

* * * * *

Exhibit E

US006099029A

United States Patent [19]

Håland et al.

[11] Patent Number: 6,099,029

[45] Date of Patent: *Aug. 8, 2000

[54] **SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR**

[75] Inventors: **Yngve Håland**, Falsterbo; **Lars-Erik Florberger**, Lidköping; **Sture Andersson**, Nacka, all of Sweden; **Simomn Valkenburg**, Macclesfield, United Kingdom; **I. Jörgen Svensson**, Saltsjö-Boo, Sweden

[73] Assignee: **Autoliv Development AB**, Vargarda, Sweden

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).
This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/127,918**

[22] Filed: **Aug. 3, 1998**

Related U.S. Application Data

[63] Continuation of application No. 08/604,052, Feb. 20, 1996, Pat. No. 5,788,270.

[30] **Foreign Application Priority Data**

Feb. 20, 1995 [GB] United Kingdom 9503267

[51] **Int. Cl.**[7] **B60R 21/22**; B60R 21/24

[52] **U.S. Cl.** **280/729**; 280/730.2

[58] **Field of Search** 280/730.2, 730.1, 280/729, 743.1, 743.2, 728.1, 753, 749

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,731,949	5/1973	Radke	280/743.1
3,792,873	2/1974	Buchner et al.	280/743.1
3,897,961	8/1975	Leising et al.	280/730.1
4,227,717	10/1980	Bouvier	280/753
5,322,322	6/1994	Bark et al.	280/730.2
5,333,899	8/1994	Witte	280/730.2
5,588,672	12/1996	Karlow et al.	280/730.2
5,957,487	9/1999	Stutz	280/730.2

FOREIGN PATENT DOCUMENTS

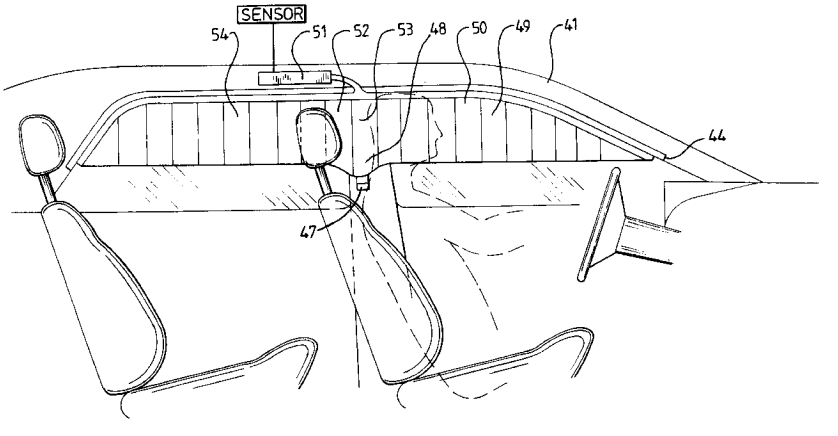
0584781	3/1994	European Pat. Off. .	
0590518	4/1994	European Pat. Off. .	
2222621	11/1972	Germany .	
4134995	3/1993	Germany .	
4307175	9/1993	Germany	280/730.2
4231522	3/1994	Germany	280/729
5-131889	5/1993	Japan	280/729
962946	7/1964	United Kingdom	280/749
2191450	12/1987	United Kingdom .	
2261636 0	5/1993	United Kingdom .	
2278812	12/1994	United Kingdom .	
90/09295	8/1990	WIPO .	
94/19215	9/1994	WIPO .	

Primary Examiner—Peter C. English
Attorney, Agent, or Firm—Venable; George H. Spencer; Catherine M. Voorhees

[57] **ABSTRACT**

A safety device for a motor vehicle which has a door frame and a door contained within the door frame. The safety device includes: a gas generator; a sensor for sensing at least one of a side impact and a roll-over for activating the gas generator; and an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator. The inflatable element can thus assume a non-inflated mode and an inflated mode and can further be positioned adjacent the door in an inflated-mode thereof. The inflatable element is further made of fabric and includes: a first fabric layer defining a front part thereof; a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together. The inflatable element thus incorporates a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned. The inflatable element further includes an upper edge portion which is configured to be secured to the door frame all along a non-linear part of the door frame.

8 Claims, 5 Drawing Sheets



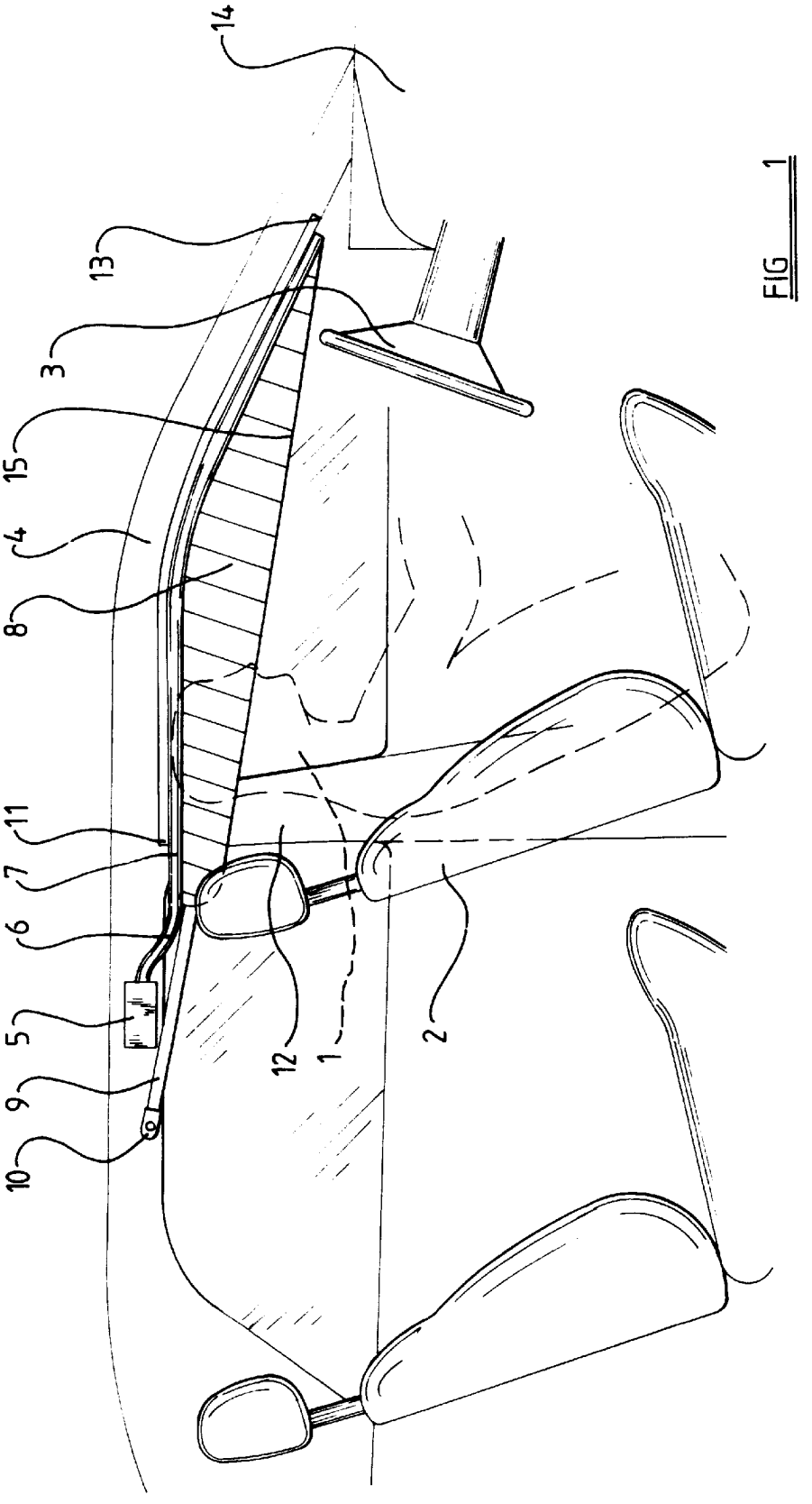


FIG 1

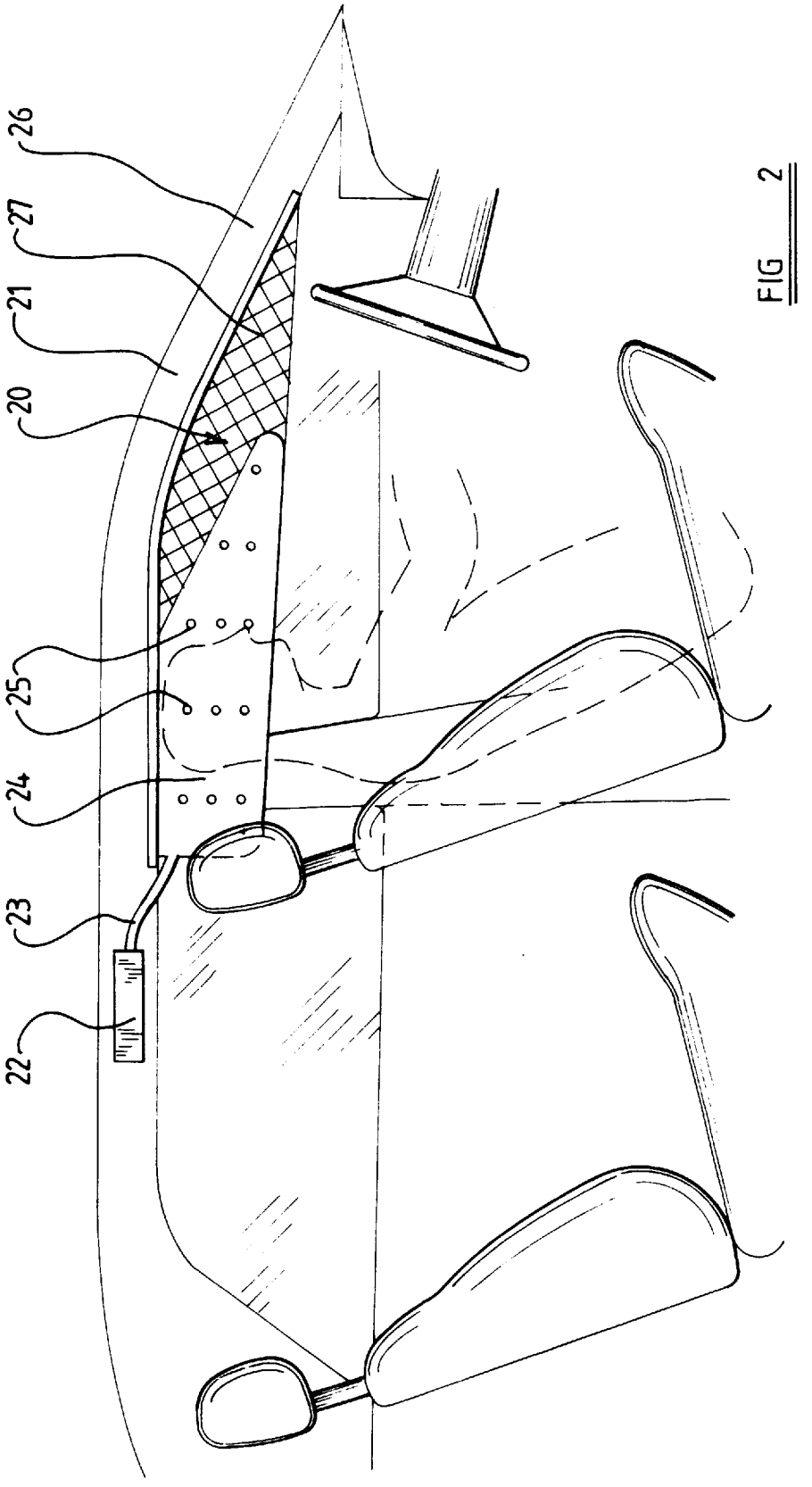


FIG 2

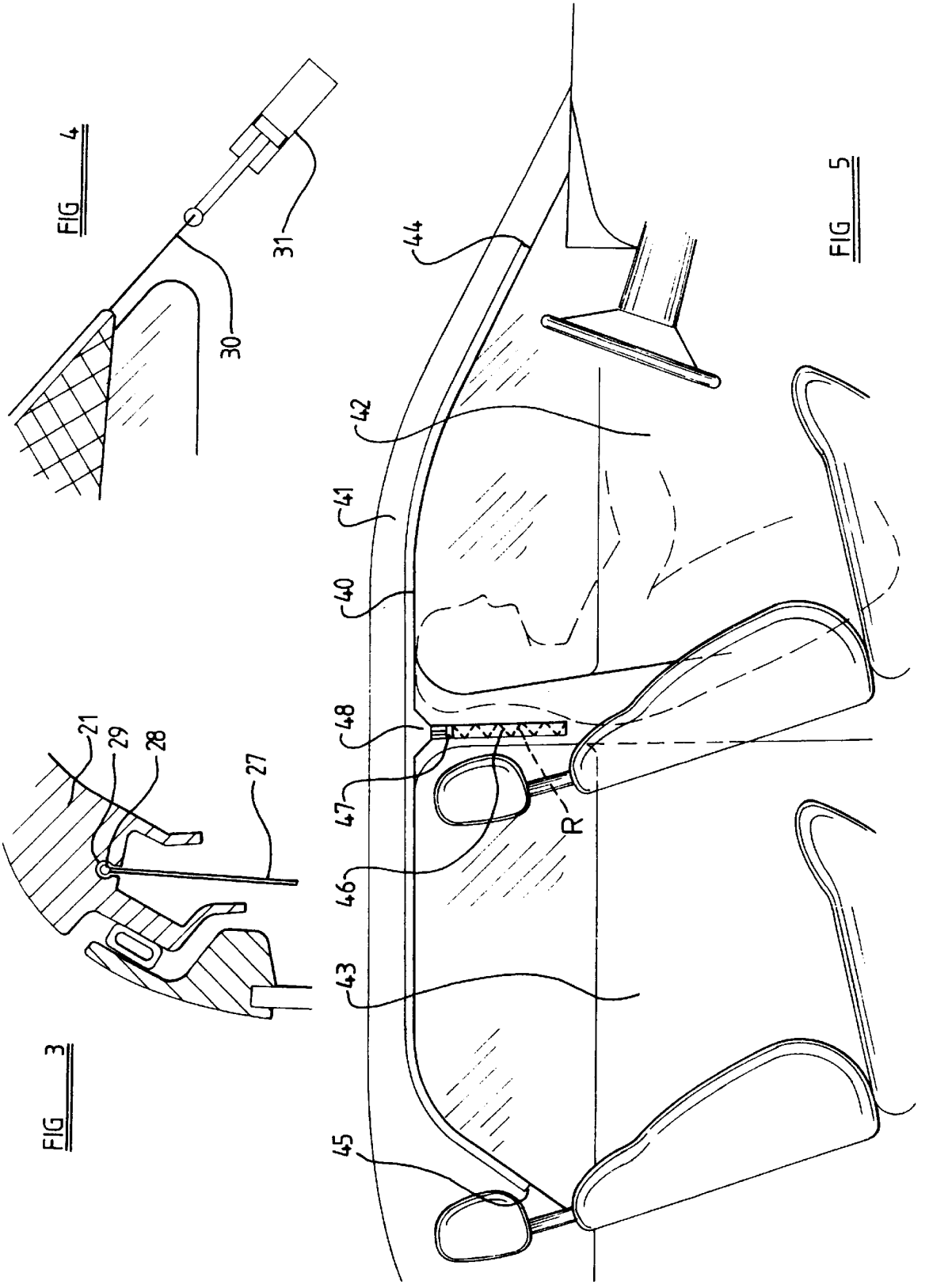


FIG 4
31
30
FIG 5
44
42
41
40
48
47
46
43
45
R
FIG 3
21
29
28
27

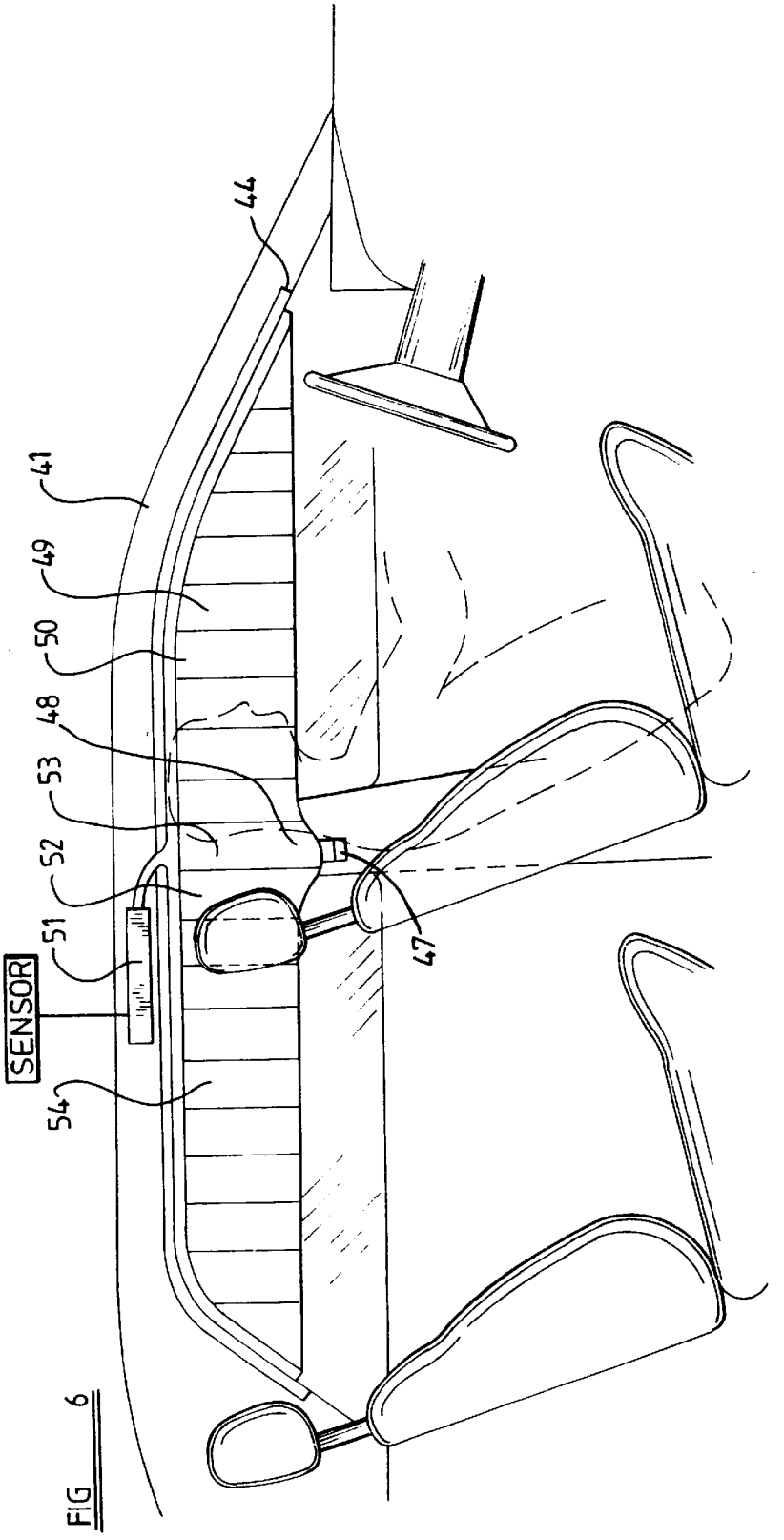


FIG 6

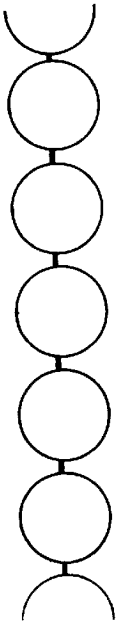


FIG 7

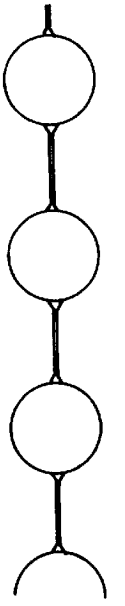


FIG 8

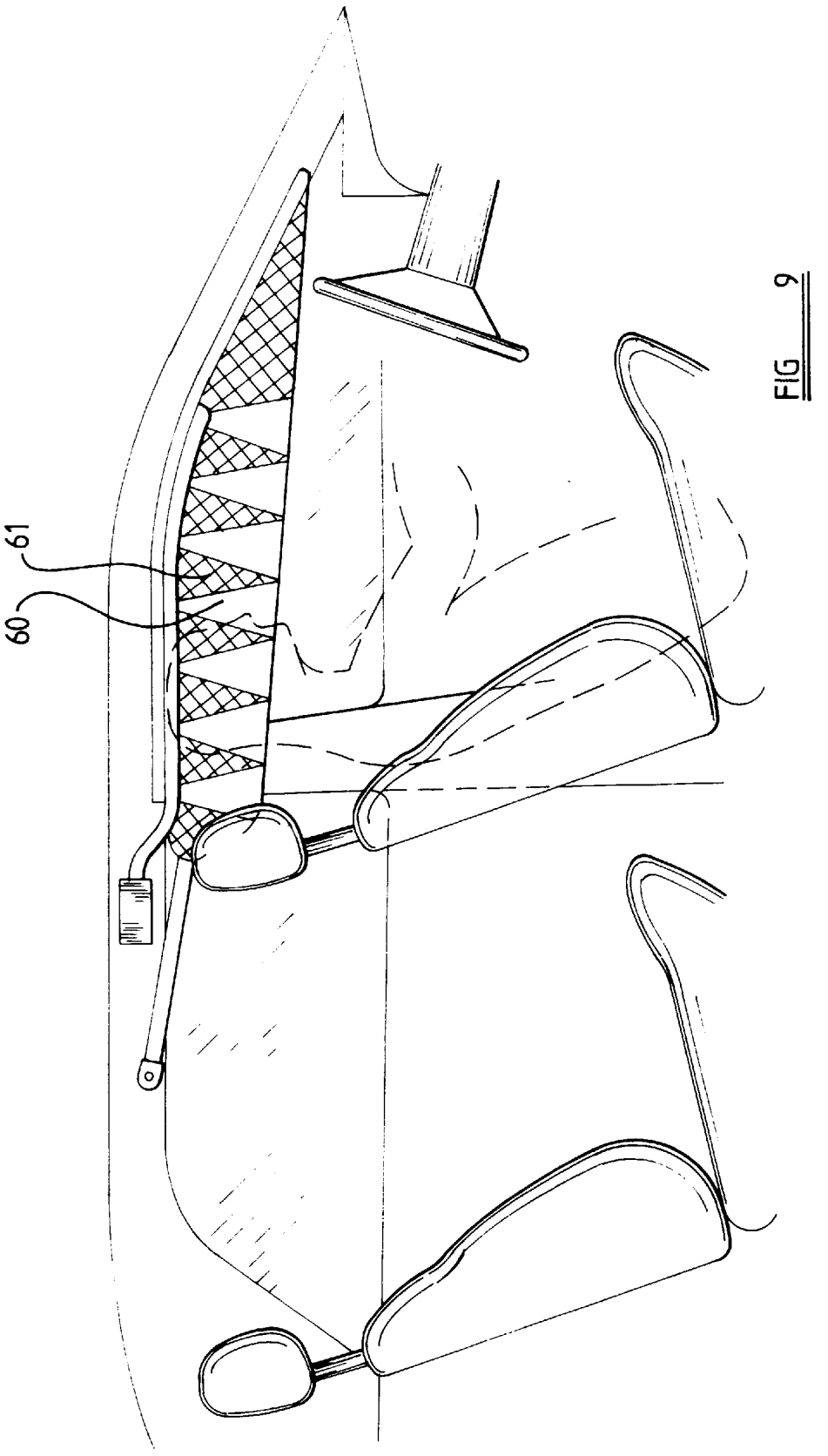


FIG 9

SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 08/604,052 filed Feb. 20, 1996 U.S. Pat. No. 5,788,270.

FIELD OF THE INVENTION

THIS INVENTION relates to a safety device, and more particulary relates to a safety device in a motor vehicle such as a motor car.

BACKGROUND OF THE INVENTION

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. U.S. Pat. No. 5,322,322 discloses such a device. An inflatable tube is initially stored in a recess in the door frame above the door of the vehicle, and the ends of the tube are pivotally anchored to fixed points on the door frame. A sensor is provided to sense when an accident occurs, and to initiate inflation of the tube. As the tube inflates its length decreases, and it then extends linearly between the two fixed points on the door frame. The inflated tube provides some protection for the head of a person sitting in the vehicle. However, the tube is inflated to a substantial pressure, and thus the head of a person in the vehicle may tend to bounce off the tube. The tube may not cover the whole of the area of the window, and may not even cover the whole of the upper part of the window. There is thus a risk that the head of the person in the vehicle may move past the tube and pass through the window opening. If a car is rolling over this is very undesirable.

SUMMARY OF THE INVENTION

This invention seeks to provide an improved safety device.

According to this invention there is provided a safety device in a motor vehicle, the device comprising a gas generator, incorporating or associated with a sensor adapted to sense a side impact or a roll-over and to activate the gas generator, and an inflatable element connected to the gas generator to be inflated by gas from the gas generator, the inflatable element being made of fabric comprising a first layer to define the front part of the inflatable element, and a second layer to define the back part of the inflatable element, selected parts of the first layer and the second layer being inter-connected to define points or lines where the front part and back part of the inflatable element are secured together, the inflatable element incorporating a plurality of substantially parallel elongate cells, the inflatable element having an edge portion secured to part of the door frame of the vehicle which is non-linear, the inflatable element, when inflated, being positioned adjacent the door contained within the door frame.

The inflatable element, when inflated, is thus located between the head of a person sitting in the vehicle and an adjacent door. Usually such a door is provided with a window and so the inflated element provides protection from breaking glass from the window, and also prevents the head of the person in the vehicle from striking the window, or from being thrown out through the window, as can happen, particularly with roll-over accidents.

Preferably the safety device is usually initially stored in a recess provided in the doorframe.

Preferably the inflatable element is made of inter-woven fabric layers, the selected parts of the first layer and the second layer being inter-woven. Preferably there is internal venting between the cells as this may reduce undesirable bounce that might occur if the cells were discrete and not vented to each other.

The cells may be immediately adjacent each other or may be spaced apart. At least some of the cells may be of conical form when inflated.

The inflatable element may be formed of a fabric with parts of the fabric being interwoven to form the cell or cells. The fabric may have a single layer weight of less than 300 g/sq m, such as a weight of 175 g/sq m.

Preferably when the inflatable element is inflated the pressure of gas is approximately 3 bar. Preferably the inflatable element, when inflated, extends past the B-post of the vehicle, to provide protection for the head of the driver. If the head of the driver should impact with the B-post in an accident the consequences could be fatal.

In one embodiment the inflatable element incorporates a strap to connect part of the inflatable element to the door frame. The strap is tight, that is, tensioned to a significant extent, when the inflatable element is inflated.

Separate means may be provided to apply tension to part of the inflatable element when it is inflated, such as a piston and cylinder, adapted to be moved by gas from a gas generator when the inflatable element is inflated, to apply tension to one edge of the inflatable element, to hold the inflated element in a desired position.

In one embodiment the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain the means in the further position. Thus a slider may be provided adapted to slide along a ratchet, and to be retained by the ratchet when it has moved to a further position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and so that further features thereof may be appreciated the invention will now be described by way of example with reference to the accompanying drawings in which

FIG. **1** is a side view of the interior of a motor vehicle illustrating a safety device in accordance with the invention in an operative state,

FIG. **2** is a side view of part of the interior of a motor vehicle illustrating another safety device in accordance with the invention in the operative state,

FIG. **3** is a sectional view of part of the embodiment of FIG. **2** in a plane perpendicular to a longitudinal axis of the vehicle,

FIG. **4** is a view of part of FIG. **2** showing an additional component of the safety device,

FIG. **5** is a side view of the interior of a motor vehicle provided with another form of safety device in accordance with the invention, before the safety device moves to the operative state,

FIG. **6** illustrates the vehicle of FIG. **5** when the safety device is in the operative state,

FIG. **7** is a sectional view of one form of safety device as shown in FIG. **1** or in FIGS. **5** and **6** in a plane perpendicular to the vertical direction,

FIG. **8** is a sectional view of another form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, and

FIG. **9** is a view of part of an alternative inflatable element for use in the embodiments of FIGS. **1**, **5** and **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1** a safety device is illustrated which is intended to provide protection for a person **1** sitting in a seat **2** in the vehicle. In any accident in which the vehicle is decelerated the person will tend to move forwardly towards the steering wheel **3**, but will be restrained by a conventional seat belt or air-bag. In the case of a side impact or roll-over, there is a risk that the head of the person **1** will strike the window in the door beside the person, or strike the B-post. There is also a risk that if, as most commonly happens, the glass in the window should break, the head of the person **1** may be thrown out of the window, especially in the case of roll-over.

The safety device shown in the operative state in FIG. **1** is initially retained in a recess provided in the door frame **4** located above the door of the vehicle. The recess extends over more than simply a linear portion of the door frame so that the two ends of the recess are not in alignment with the main part of the recess.

The safety device comprises a gas generator **5**, which is adapted to generate gas, such as cold gas. The gas generator incorporates, or is associated with, a sensor which senses a side impact and/or a roll-over situation to activate the gas generator at an appropriate instant. The gas generator is connected by a hose **6** to a duct **7**. The duct **7** forms part of an inflatable element. The inflatable element incorporates a plurality of parallel substantially vertical, substantially cylindrical cells **8**. The inflatable element may be made of interwoven fabric. Such a fabric comprises a first layer that defines the front of the inflatable element—that is to say the part that is visible in FIG. **1**—and a second layer that defines the back part—that is to say the part that is adjacent the window in FIG. **1**—selected parts of the first region and the second region being interwoven to define links in the form of points or lines where the front part and the back part of the inflatable element are secured together. A technique for making an inflatable element of inter-woven fabric is described in more detail in International Patent Publication WO90/09295.

A webbing strap **9** that forms part of the inflatable element extends from the end of the inflatable element near the duct **7** which is connected to the hose **6** to an anchoring point **10** on the door frame **4**. The edge of the duct **7** between the points **11**, adjacent the top of the B-post **12**, and **13**, at the lower part of the A-post, in the region of the dashboard **14**, is fixed securely to the door frame **4**. Consequently, it is to be understood that the upper edge of the inflatable element has a non-linear configuration which conforms with the non-linear configuration of the upper part of the door frame **4** by virtue of the inflatable element being secured, at an upper edge portion thereof, to the door frame all along a non-linear part of the door frame as shown in the figures. A substantial part, in fact virtually all, of the upper edge of the inflatable element is secured to the upper part of the door frame.

When an accident such as side impact occurs the gas generator generates cold gas which passes through the hose **6** to the duct **7**, and then inflates the cells **8**. The inflatable element thus moves from its initial stored position within the recess in the door frame to the operative position shown in

FIG. **1**. The inflatable element then extends downwardly from the top of the door frame to form a flat structure located between the head of the person **1** and the adjacent window. As the cylindrical cells inflate the length of the lower edge **15** of the inflatable element is reduced, and thus the lower edge, together with the webbing strap **9** extend substantially tightly from the point **10** to, the point **13**. It is to be noted that the part of the door frame **4** between the points **10** and **13** is not linear, and defines, with the linear lower edge of the inflated element, a triangular area which is covered by the inflated element.

The lower edge of the inflated element decreases by about 10% between the uninflated state and the inflated state. The inflated element is fully inflated within about 15 ms. The total thickness of the inflated element, when inflated is approximately 30–40 mm. The seams of interweaving of the front part and the back part of the inflated element are approximately 30–40 mm apart, so that the resultant cells are cylindrical when inflated. The total volume of gas within the inflated element may be between 7 and 9 liters, and the gas may be at a pressure of about 3 bar. While the inflated element is not provided with a vent to vent gas from within the element to the atmosphere, so that the inflated element, when inflated, remains inflated for a long period of time—to provide protection in the case of a protracted roll-over—there is venting between at least selected adjacent cells **8**, to avoid any severe rebound. Thus if the head of the person in the vehicle impacts with the inflated element the pressure of gas within the whole element, or at least a substantial part of the element will rise, thus giving a "soft" impact. If each cell were sealed with no venting of this type, there would be a risk of severe rebound.

The weight of the fabric should be kept to be as low as possible, so that if the inflatable element should impact with the head of the person in the vehicle as the inflatable element is inflated no harm will be done. It is thought that a material having a weight of less that 300 g/sq m, such as 175 g/sq m may be used.

It is to be noted that part of the inflated element extends rearwardly beyond the point **11**, and is thus located between the head of the person **1** and the top of the B-post. Thus the risk of the head of the person impacting with the B-post is minimized. Since the upper edge of the inflatable element is secured to the upper part of the door frame along substantially the whole of its length, there is virtually no risk that the head of the occupant will pass between the upper edge of the inflatable element and the upper part of the door frame, with the head of the occupant of the vehicle thus inadvertently emerging from the body shell of the vehicle.

FIGS. **2** to **4** illustrate a second embodiment of the invention. In this embodiment an inflatable element **20** is provided which is initially stored in a recess provided in the door frame **21** of a motor vehicle. A gas generator **22** is provided, which again incorporates or is associated with a sensor or detector which activates the gas generator at an appropriate time. The gas generator is connected by a duct **23** to an inflatable part **24** of the inflatable element **20**. The gas generator **22** is located in the door-frame **21** of the vehicle, but alternatively could be positioned in the B-post.

The inflatable part **24** or the inflatable section of the inflatable element **20** is formed from two layers of fabric, as in the embodiment of FIG. **1**, with the front layer and the back layer of the fabric being woven together at selected points **25**. The selected points **25** are arranged in vertically extending columns and serve to divide the inflatable part **24** into a plurality of vertical parallel chambers. The spaces

between the selected points **25** permit internal venting between adjacent chambers.

The inflatable part **24** of the inflatable element **20** is adapted to be located adjacent the head of an occupant of the motor vehicle, and, towards the rear of the inflatable element, when in the position illustrated in FIG. **2**, the inflatable part of the inflatable element extends from the top to the bottom of the inflatable element in a rear region and subsequently, the upper edge of the inflatable part extends downwardly towards the lower edge of the inflatable element, in a sense directed towards the A-Post **26**. The remaining part or non-inflatable section of the inflatable element comprises a web or sheet **27** which extends from the inflatable parts **24** to the part of the door-frame **21** above the door and to the A-post. The web or sheet **27** is thus secured to parts of the door frame that are non-linear. It is to be appreciated, therefore, that in this embodiment of the invention the upper edge of the inflatable element is of non-linear form and is of the same configuration as the non-linear part of the door frame which extends forwardly from the B-post and which incorporates the A-post. The upper edge of the inflatable element, or at least a substantial part of that upper edge, is securely fixed to the upper part of the door frame, thus again minimizing any risk of the head of the occupant emerging from the body shell between the upper edge of the inflatable element and the upper part of the door frame.

Referring to FIG. **3** the edge of the sheet **27** that is secured to the door frame **21** may terminate with a bead **28** that is received within a slot **29** formed in the door frame, the mouth of the slot being narrower than the base so that the bead **28** can slide axially within the slot, but cannot escape from the slot. A cable **30** is connected to the end of the bead, as can be seen in FIG. **4**, the cable being connected to a tensioning device **31**. The tensioning device may comprise a piston in a cylinder associated with a gas generator to generate gas which moves the piston within the cylinder to apply tension to the cable **30** and thus to the bead **28**. A ratchet or the like may hold the piston in place when it has been moved by the gas. The gas generator that supplies gas to the piston may be the gas generator **22** or may be a separate gas generator that is triggered simultaneously with the main gas generator.

When an accident occurs the inflatable element **20** moves from its stored position to the operative position shown in FIG. **2**, and tension is applied to the inflatable element **20** by the distention of the inflatable part **24**, and by the tension applied to the bead **28**. The inflated element **20** is thus held firmly in position to provide protection for the head of the person sitting in the motor vehicle. The thickness of the element **20** and the weight of the material used should be as described with reference to the embodiment of FIG. **1**.

FIGS. **5** and **6** illustrate another embodiment of the invention intended to provide protection not only for a person in the front seat of a motor vehicle such as a motor car, but also for a person in the rear seat of the vehicle.

Referring to FIG. **5**, a recess **40** is provided in the doorframe **41** of a motor vehicle, the recess extending over both the front door **42** and the rear door **43**. The recess extends from a point **44** located near the lower end of the A-post to a point **45** located near the lower end of the C-post.

A channel **46** is provided on the B-post, extending vertically In the channel **46** is a ratchet R, and received within the upper end of the channel **46** is a ratchet engaging slide member **47**. The slide member **47** is connected to a tab **48** which forms part of an inflatable element **49** see (FIG. **6**), which is initially stored within the recess **40**.

The inflatable element **49** is shown in the inflated state in FIG. **6**.The inflatable element hag its top edge **50** secured to the part of the door frame **41** that extends above the doors **42**, **43** of the motor vehicle. The top edge of the inflatable element is of non-linear configuration, and has a configuration which corresponds with the non-linear configuration of the upper part of the door frame. The design of the inflatable element is similar to that shown in FIG. **1**, with the inflatable element presenting a plurality of parallel cells, which when inflated are substantially cylindrical. The structure of the inflatable element **49** may be the same as that described with reference to FIG. **1**.

A gas generator **51** is provided which is connected to the inflatable element in such a way that when the gas generator is activated by a sensor that is formed integrally with the gas generator, or which is associated with the gas generator, and which responds to a side impact or to a roll-over situation to activate the gas generator, gas is initially supplied to the cells **52**, **53**, which are aligned with the tab **48**. Thus initially, as the inflatable element **49** inflates, the cells **52** and **53** inflate and move the ratchet engaging slide member **47** downwardly. The ratchet engaging slide member thus moves down the slot **46** to the position shown in FIG. **6**. The ratchet engaging slide member **47** engages the ratchet, and thus holds the tab **48** in its lower position.

The rest of the cells **54** of the inflatable element are then inflated, and the inflatable element then extends fully across the upper parts of the windows in the doors **42**, **43** of the motor vehicle. It can be seen that the lower edge of the inflated element **49** extends between the points **44** and **45** at the ends of the recess **40**. As the inflatable element **49** inflates, so the length of the lower edge thereof decreases as a consequence of the inflation of the cells of the inflatable element. This reduction in the length of the lower edge, together with the action of the ratchet engaging slide member **47** ensures that the inflated element is retained in position as illustrated after it has been inflated.

FIG. **7** is a cross section showing the nature of the cells of the inflated element of FIG. **1** and of FIGS. **5** and **6**. It can be seen that the cells are immediately adjacent to each other and are only separated by narrow regions where the fabric forming the front part of the inflated element has been woven with the fabric forming the back part of the inflated element. However, FIG. **8** illustrates an alternative possibility, in which the regions of fabric between the cells that are woven together are relatively wide, the cells thus being separated by webs of fabric. The advantage of this latter possibility is that a smaller volume of gas may be required to fully inflate the inflatable elements, meaning that the inflatable element may be inflated more rapidly.

FIG. **9** illustrates an alternative form of inflatable element comprising a plurality of cells **60** or inflatable section. The upper edge of the inflatable element is of non-linear form and is connected to the non-linear portion of the door frame above the door. The configuration of the upper edge of the inflatable element and the configuration of the door frame correspond. It can be seen that each cell **60** is of substantially conical form, the cells being arranged adjacent each other and being parallel with each other. Between the cells are inverted triangular portions **61** or non-inflatable sections where the fabric forming the cells is interwoven.

When cells of this type are inflated, the length of the lower edge of the arrangement contracts, whereas the length of the upper edge of the arrangement remains constant.

An arrangement of this type can be used, therefore, to ensure that the lower edge of the element, when inflated, is under some tension.

Whilst in the arrangement illustrated in FIG. **9**, the cells are immediately adjacent each other, it is to be appreciated that a similar effect may be achieved if the cells are spaced apart. It is possible to replace at least part of the inverted triangular region **61** with further conical cells of an inverted orientation.

Whilst in the described embodiments of the invention, the inflatable element has been described as being made utilising a technique in which two layers of fabric are interwoven to define points or lines where the front layer and the rear layer are interwoven, it would be possible to form embodiments of the invention utilising two discrete layers of fabric which are interconnected by stitching.

What is claimed is:

1. A safety device in a motor vehicle having a door frame and front and rear doors contained within the door frame, the safety device comprising:

a gas generator;

a sensor associated with said gas generator for sensing one of a side impact and a roll-over and activating said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element being made of fabric and comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected to define points where the front part and the back part of said inflatable element are secured together forming elongated cells; and

an upper edge portion secured at selected points to a non-linear part of the door frame which extends over both the front door and the rear door, whereby, when inflated, said inflatable element is positioned adjacent the doors contained in the door frame.

2. A safety device according to claim **1**, wherein the selected parts of the first fabric layer and the second fabric layer are interconnected in a plurality of predetermined areas for defining a plurality of links, the elongated cells being defined between the links, each cell defining a longitudinal axis, the cells being positioned so that the longitudinal axes of the cells extend generally transversely to a lower edge of the inflatable element such that, upon inflation of the inflatable element with gas from the gas generator, the length of the lower edge of the inflatable element is reduced.

3. A safety device according to claim **2**, wherein the inflatable element is made of interwoven fabric layers, said links being constituted by selected parts of the first layer and selected parts of the second layer, with the selected parts of the first layer and the second layer being interwoven.

4. A safety device according to claim **2**, wherein the axes of the cells are substantially parallel.

5. A safety device according to claim **1**, wherein the cells are configured to be in gas flow communication with one another.

6. A safety device according to claim **1**, wherein the cells are immediately adjacent each other.

7. A safety device according to claim **1**, wherein the cells are spaced apart from each other.

8. A safety device according to claim **1**, wherein at least some of the cells are of conical form when inflated.

* * * * *

Exhibit F

US006402192B2

(12) **United States Patent**
Håland et al.

(10) **Patent No.: US 6,402,192 B2**
(45) **Date of Patent: *Jun. 11, 2002**

(54) **SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR**

(75) Inventors: **Yngve Håland**, Falsterbo; **Lars-Erik Florberger**, Lidköping; **Sture Andersson**, Nacka, all of (SE); **Simomn Valkenburg**, Macclesfield (GB); **I. Jörgen Svensson**, Saltsjö-Boo (SE)

(73) Assignee: **Autoliv Development AB**, Vargarda (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/949,943**

(22) Filed: **Sep. 12, 2001**

Related U.S. Application Data

(63) Continuation of application No. 09/589,402, filed on Jun. 8, 2000, now Pat. No. 6,312,009, which is a continuation of application No. 09/127,918, filed on Aug. 3, 1998, now Pat. No. 6,099,029, which is a continuation of application No. 08/604,052, filed on Feb. 20, 1996, now Pat. No. 5,788,270.

(30) **Foreign Application Priority Data**

Feb. 20, 1995 (GB) 9503267

(51) **Int. Cl.**[7] **B60R 21/22**; B60R 21/24
(52) **U.S. Cl.** **280/729**; 280/730.2
(58) **Field of Search** 280/730.2, 730.1, 280/729, 743.1, 743.2, 728.1, 753, 749

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,731,949	A	5/1973	Radke
3,792,873	A	2/1974	Buchner et al.
3,897,961	A	8/1975	Leising et al.
4,227,717	A	10/1980	Bouvier
5,322,322	A	6/1994	Bark et al.
5,333,899	A	8/1994	Witte
5,588,672	A	12/1996	Karlow et al.

FOREIGN PATENT DOCUMENTS

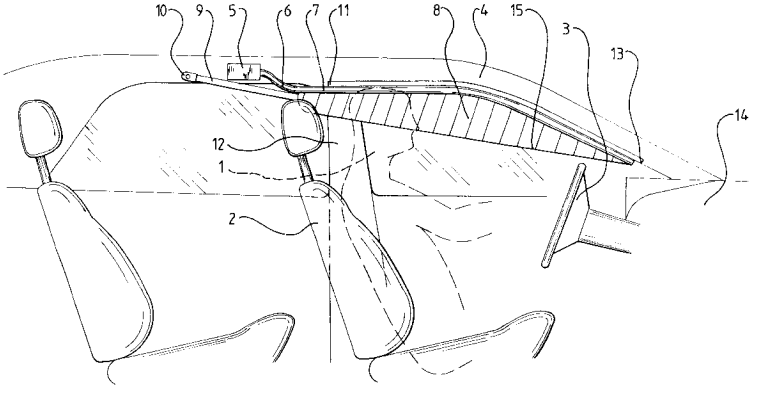
DE	2222621	11/1972
DE	4134995	3/1993
DE	4307175	9/1993
DE	4231522	3/1994
EP	0584781	3/1994
EP	0590518	4/1994
GB	962946	7/1964
GB	2191450	12/1987
GB	2261636	5/1993
GB	2278812	12/1994
JP	5-131889	5/1993
WO	90/09295	8/1990
WO	94/19215	9/1994

Primary Examiner—Peter English
(74) *Attorney, Agent, or Firm*—Venable; Robert Kinberg; Catherine M. Voorhees

(57) **ABSTRACT**

A safety device for a motor vehicle which has a door frame and a door contained within the door frame includes: a gas generator; a sensor for sensing at least one of a side impact and a roll-over for activating the gas generator; and an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator. The inflatable element can thus assume a non-inflated mode and an inflated mode and can further be positioned adjacent the door in an inflated-mode thereof. The inflatable element is further made of fabric and includes: a first fabric layer defining a front part thereof; a second fabric layer defining a back part thereof, selected parts of the first fabric layer and second fabric layer being interconnected for defining one of linear and point shaped links where the first fabric layer and the second fabric layer are directly secured together. The inflatable element thus incorporates a plurality of substantially parallel elongated cells defined between the links, the cells being configured such that, upon inflation of the inflatable element with the gas from the gas generator, a lower edge portion of the inflatable element is tensioned. The inflatable element further includes an upper edge portion which is configured to be secured to the door frame all along a non-linear part of the door frame.

22 Claims, 5 Drawing Sheets



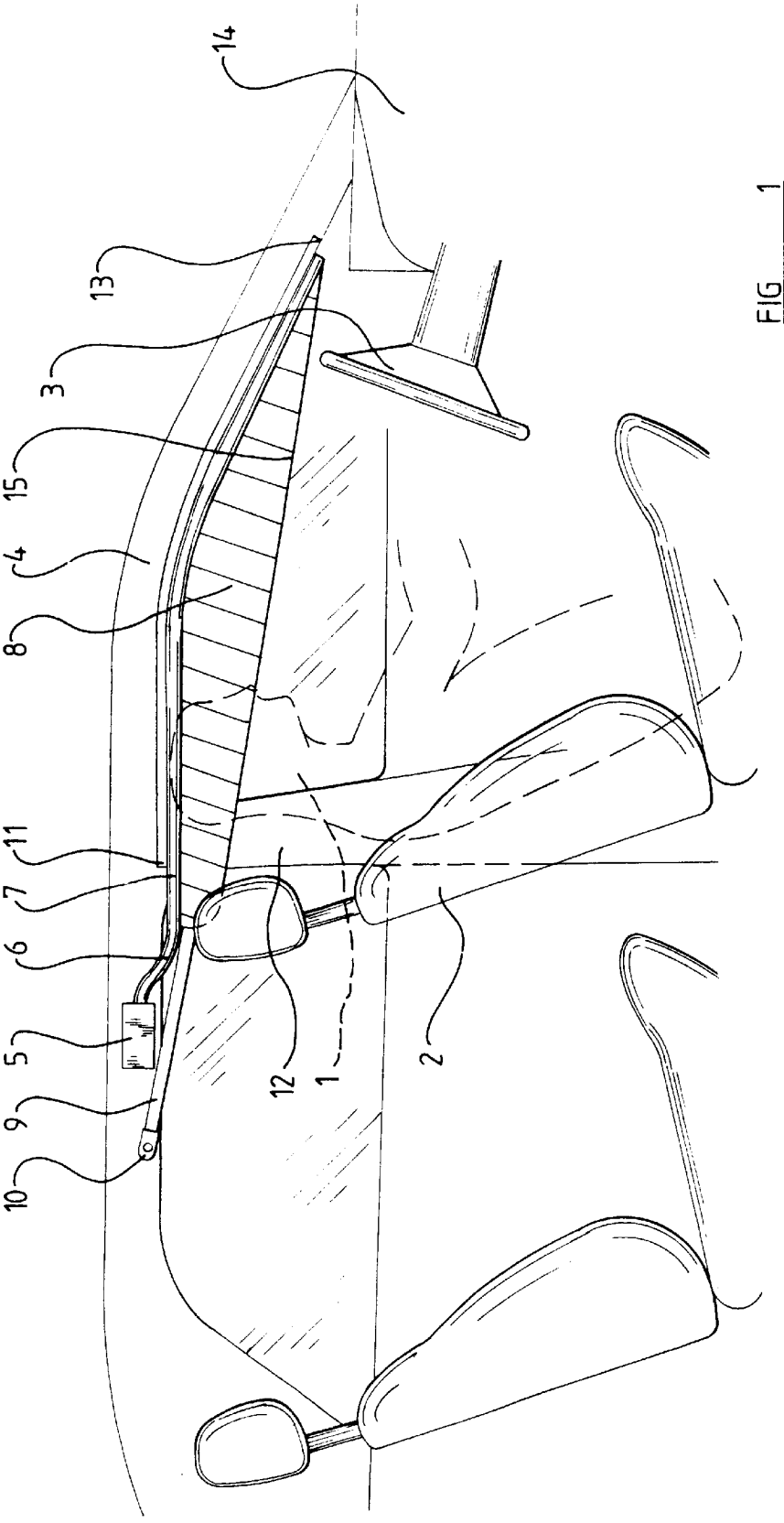


FIG 1

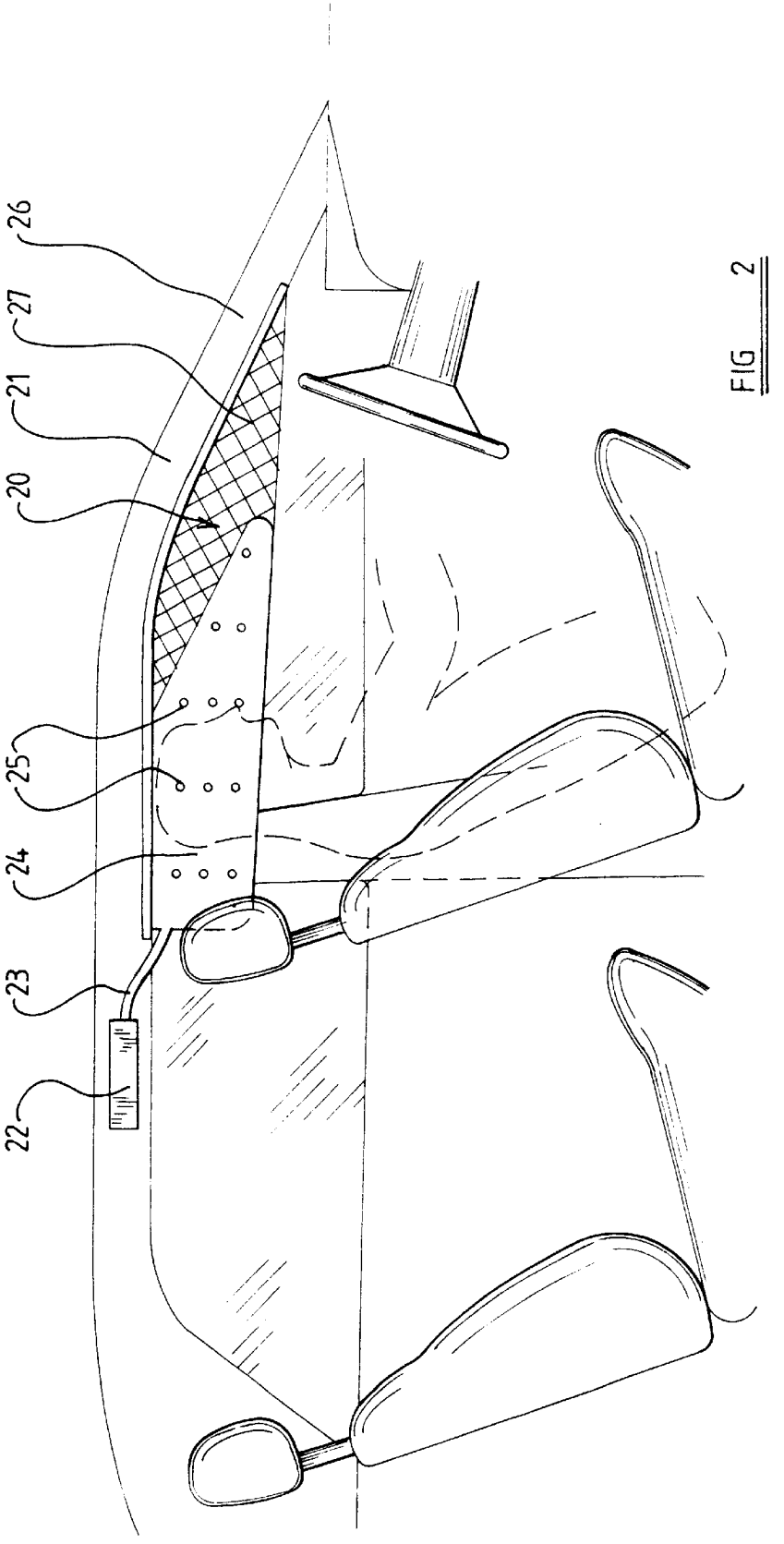


FIG 2

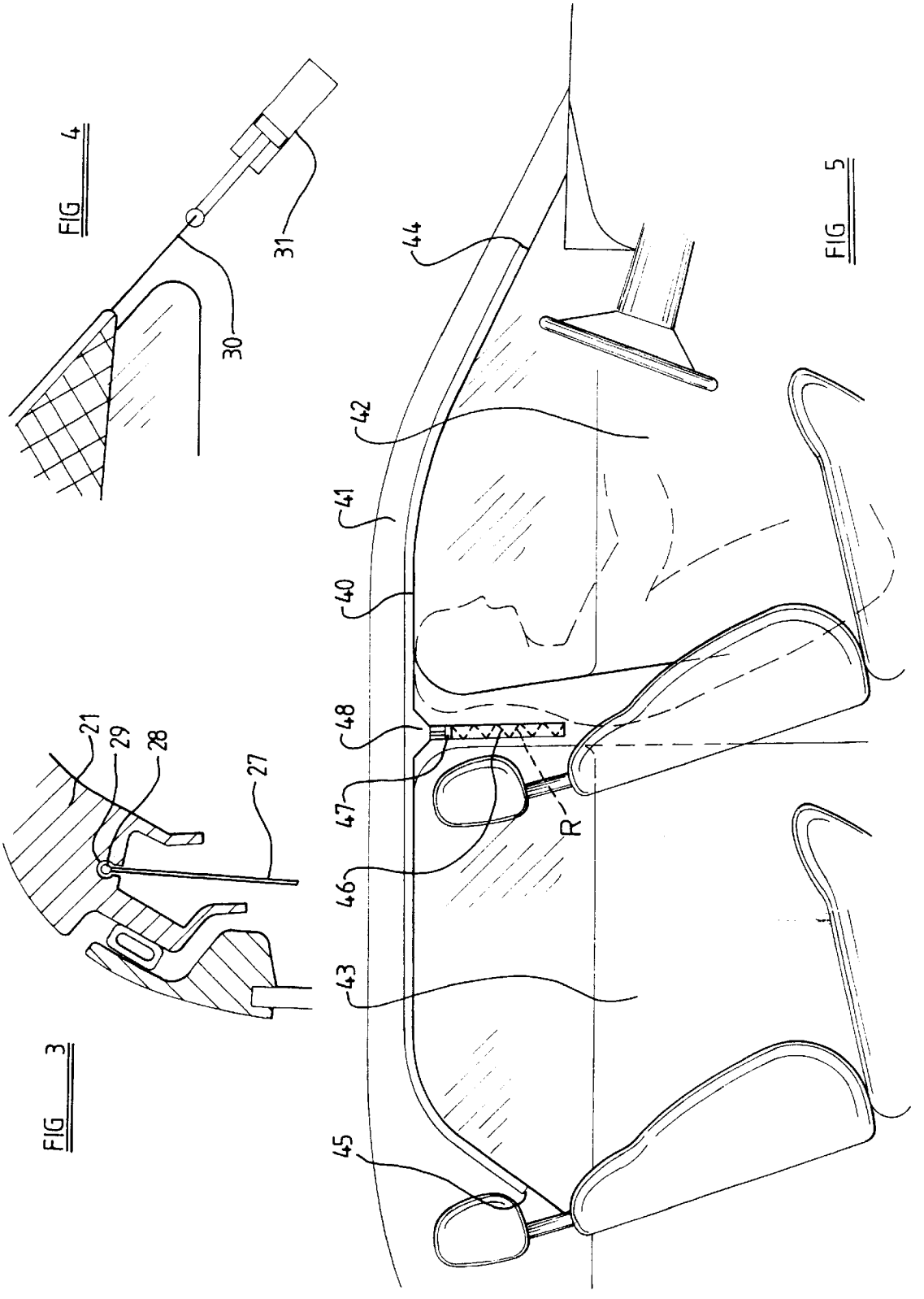


FIG 4
31
30
FIG 5
44
42
41
40
48
47
46
43
45
R
FIG 3
21
29
28
27

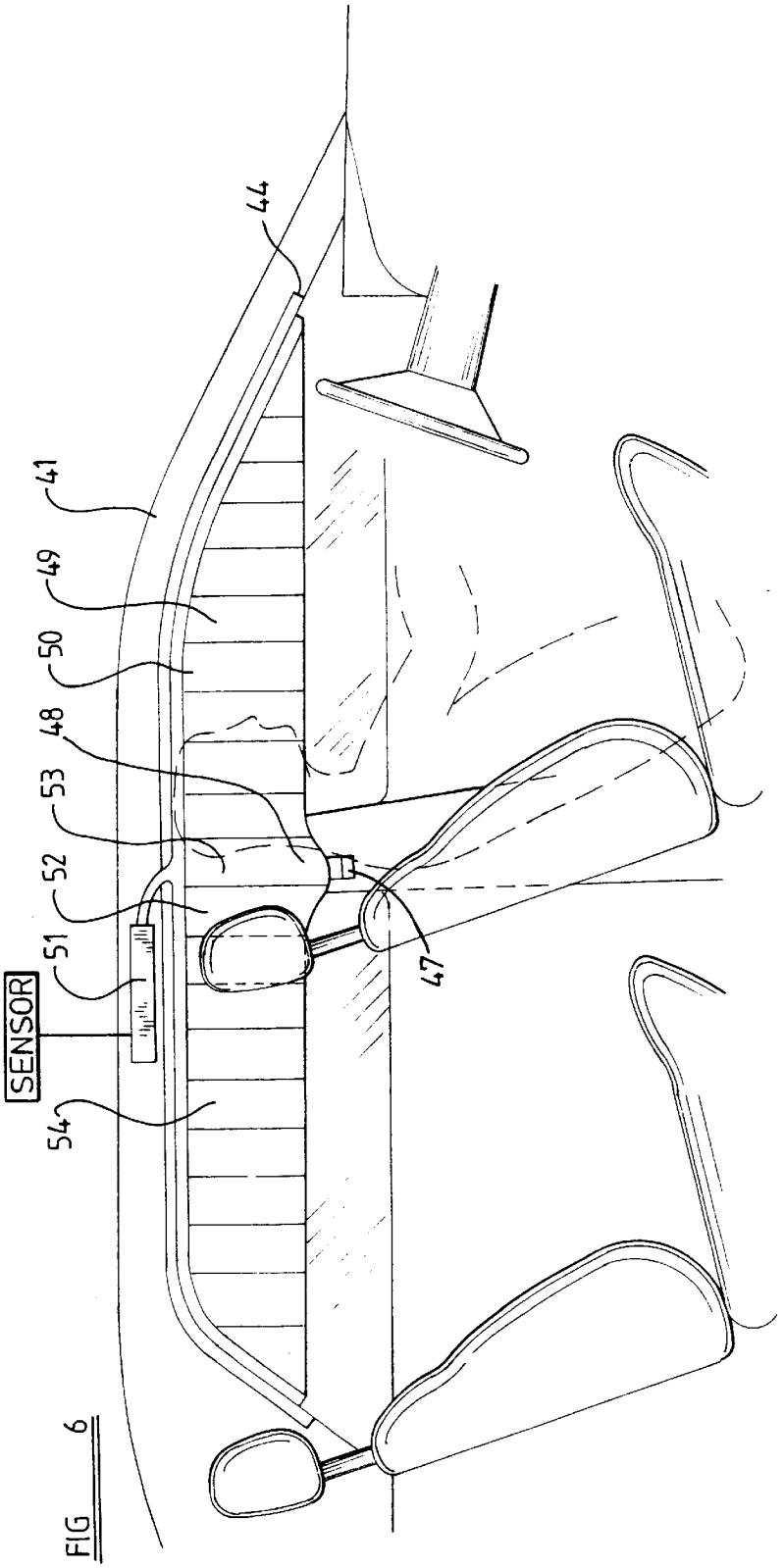


FIG 6

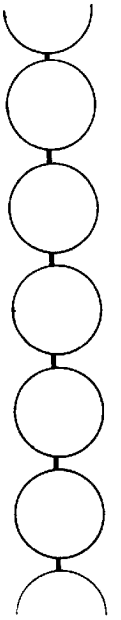


FIG 7

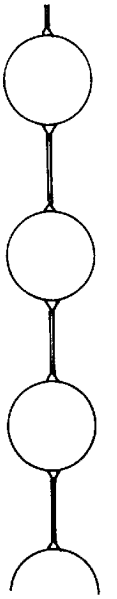


FIG 8

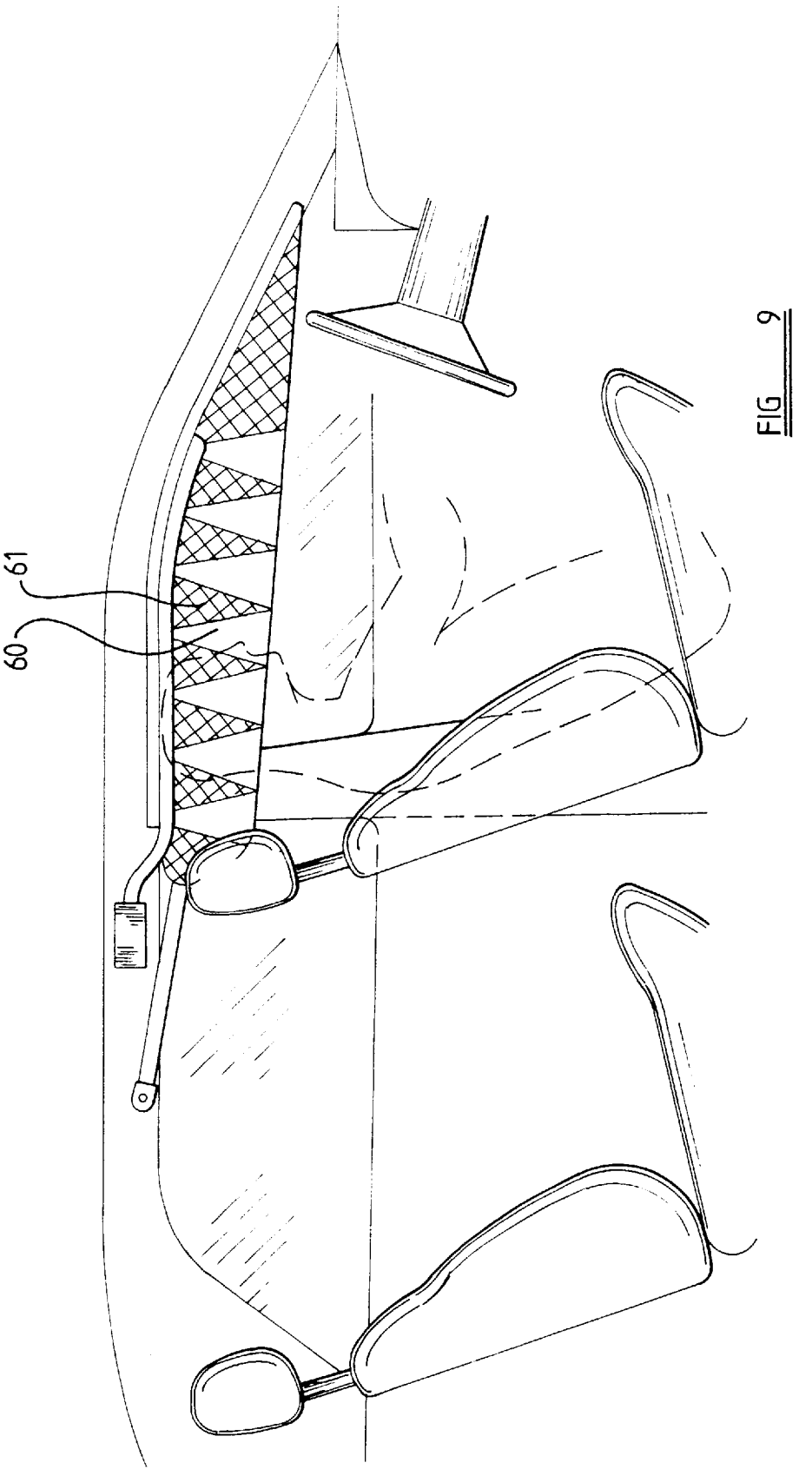


FIG 9

SIDE IMPACT AND ROLL OVER INFLATABLE HEAD PROTECTOR

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 09/589,402 filed Jun. 8, 2000, now, U.S. Pat. No. 6,312,009 which is a continuation of U.S. application Ser. No. 09/127, 918, filed Aug. 3, 1998, now U.S. Pat. No. 6,099,029 which is a continuation of U.S. application Ser. No. 08/604,052, filed Feb. 20, 1996, now U.S. Pat. No. 5,788,270.

FIELD OF THE INVENTION

THIS INVENTION relates to a safety device, and more particulary relates to a safety device in a motor vehicle such as a motor car.

BACKGROUND OF THE INVENTION

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured. It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. U.S. Pat. No. 5,322,322 discloses such a device. An inflatable tube is initially stored in a recess in the door frame above the door of the vehicle, and the ends of the tube are pivotally anchored to fixed points on the door frame. A sensor is provided to sense when an accident occurs, and to initiate inflation of the tube. As the tube inflates its length decreases, and it then extends linearly between the two fixed points on the door frame. The inflated tube provides some protection for the head of a person sitting in the vehicle. However, the tube is inflated to a substantial pressure, and thus the head of a person in the vehicle may tend to bounce off the tube. The tube may not cover the whole of the area of the window, and may not even cover the whole of the upper part of the window. There is thus a risk that the head of the person in the vehicle may move past the tube and pass through the window opening. If a car is rolling over this is very undesirable.

SUMMARY OF THE INVENTION

This invention seeks to provide an improved safety device.

According to this invention there is provided a safety device in a motor vehicle, the device comprising a gas generator, incorporating or associated with a sensor adapted to sense a side-impact or a roll-over and to activate the gas generator, and an inflatable element connected to the gas generator to be inflated by gas from the gas generator, the inflatable element being made of fabric comprising a first layer to define the front part of the inflatable element, and a second layer to define the back part of the inflatable element, selected parts of the first layer and the second layer being interconnected to define points or lines where the front part and back part of the inflatable element are secured together, the inflatable element incorporating a plurality of substantially parallel elongate cells, the inflatable element having an edge portion secured to part of the door frame of the vehicle, which is non-linear, the inflatable element, when inflated, being positioned adjacent the door contained within the door frame.

The inflatable element, when inflated, is thus located between the head of a person sitting in the vehicle and an adjacent door. Usually such a door is provided with a window and so the inflated element provides protection from breaking glass from the window, and also prevents the head of the person in the vehicle from striking the window, or from being thrown out through the window, as can happen, particularly with roll-over accidents.

Preferably the safety device is usually initially stored in a recess provided in the doorframe.

Preferably the inflatable element is made of interwoven fabric layers, the selected parts of the first layer and the second layer being interwoven. Preferably there is internal venting between the cells as this may reduce undesirable bounce that might occur if the cells were discrete and not vented to each other.

The cells may be immediately adjacent each other or may be spaced apart. At least some of the cells may be of conical form when inflated.

The inflatable element may be formed of a fabric with parts of the fabric being interwoven to form the cell or cells. The fabric may have a single layer weight of less than 300 g/sq m, such as a weight of 175 g/sq m.

Preferably when the inflatable element is inflated the pressure of gas is approximately 3 bar. Preferably the inflatable element, when inflated, extends past the B-post of the vehicle, to provide protection for the head of the driver. If the head of the driver should impact with the B-post in an accident the consequences could be fatal.

In one embodiment the inflatable element incorporates a strap to connect part of the inflatable element to the door frame. The strap is tight, that is, tensioned to a significant extent, when the inflatable element is inflated.

Separate means may be provided to apply tension to part of the inflatable element when it is inflated, such as a piston and cylinder, adapted to be moved by gas from a gas generator when the inflatable element is inflated, to apply tension to one edge of the inflatable element, to hold the inflated element in a desired position.

In one embodiment the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain the means in the further position. Thus, a slider may be provided adapted to slide along a ratchet, and to be retained by the ratchet when it has moved to a further position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and so that further features thereof may be appreciated the invention will now be described by way of example with reference to the accompanying drawings in which

FIG. **1** is a side view of the interior of a motor vehicle illustrating a safety device in accordance with the invention in an operative state,

FIG. **2** is a side view of part of the interior of a motor vehicle illustrating another safety device in accordance with the invention in the operative state,

FIG. **3** is a sectional view of part of the embodiment of FIG. **2**, in a plane perpendicular to a longitudinal axis of the vehicle.

FIG. **4** is a view of part of FIG. **2** showing an additional component of the safety device,

FIG. **5** is a side view of the interior of a motor vehicle provided with another form of safety device in accordance with the invention, before the safety device moves to the operative state,

FIG. **6** illustrates the vehicle of FIG. **5** when the safety device is in the operative state,

FIG. **7** is a sectional view of one form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, in a plane perpendicular to the vertical direction.

FIG. **8** is a sectional view of another form of safety device as shown in FIG. **1** or in FIGS. **5** and **6**, and

FIG. **9** is a view of part of an alternative inflatable element for use in the embodiments of FIGS. **1**, **5** and **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1** a safety device is illustrated which is intended to provide protection for a person **1** sitting in a seat **2** in the vehicle. In any accident in which the vehicle is decelerated the person will tend to move forwardly towards the steering wheel **3**, but will be restrained by a conventional seat belt or air-bag. In the case of a side impact or roll-over, there is a risk that the head of the person **1** will strike the window in the door beside the person, or strike the B-post. There is also a risk that if, as most commonly happens, the glass in the window should break, the head of the person **1** may be thrown out of the window, especially in the case of roll-over.

The safety device shown in the operative state in FIG. **1** is initially retained in a recess provided in the door frame **4** located above the door of the vehicle. The recess extends over more than simply a linear portion of the door frame so that the two ends of the recess are not in alignment with the main part of the recess.

The safety device comprises a gas generator **5**, which is adapted to generate gas, such as cold gas. The gas generator incorporates, or is associated with, a sensor which senses a side impart and/or a roll-over situation to activate the gas generator at an appropriate instant. The gas generator is connected by a hose **6** to a duct **7**. The duct **7** forms part of an inflatable element. The inflatable element incorporates a plurality of parallel substantially vertical, substantially cylindrical cells **8**. The inflatable element may be made of interwoven fabric. Such a fabric comprises a first layer that defines the front of the inflatable element—that is to say the part that is visible in FIG. **1**—and a second layer that defines the back part—that is to say the part that is adjacent the window in FIG. **1**—selected parts of the first region and the second region being interwoven to define links in the form of points or lines where the front part and the back part of the inflatable element are secured together. A technique for making an inflatable element of interwoven fabric is described in more detail in International Patent Publication WO 90/09295.

A webbing strap **9** that forms part of the inflatable element extends from the end of the inflatable element near the duct **7** which is connected to the hose **6** to an anchoring point **10** on the door frame **4**. The edge of the duct **7** between the points **11**, adjacent the top of the B-post **12**, and **13**, at the lower part of the A-post, in the region of the dashboard **14**, is fixed securely to the door frame **4**. Consequently, it is to be understood that the upper edge of the inflatable element has a non-linear configuration which conforms with the non-linear configuration of the upper part of the door frame **4** by virtue of the inflatable element being secured, at an upper edge portion thereof, to the door frame all along a non-linear part of the door frame as shown in the figures. A substantial part, in fact virtually all, of the upper edge of the inflatable element is secured to the upper part of the door frame.

When an accident such as side impart occurs the gas generator generates cold gas which passes through the hose **6** to the duct **7**, and then inflates the cells **8**. The inflatable element thus moves from its initial stored position within the recess in the door frame to the operative position shown in FIG. **1**. The inflatable element then extends downwardly from the top of the door frame to form a flat structure located between the head of the person **1** and the adjacent window. As the cylindrical cells inflate the length of the lower edge **15** of the inflatable element is reduced, and thus the lower edge, together with the webbing strap **9** extend substantially tightly from the point **10** to the point **13**. It is to be noted that the part of the door frame **4** between the points **10** and **13** is not linear, and defines, with the linear lower edge of the inflated element, a triangular area which is covered by the inflated element.

The lower edge of the inflated element decreases by about 10% between the uninflated state and the inflated state. The inflated element is fully inflated within about 15 ms. The total thickness of the inflated element, when inflated is approximately 30–40 mm. The seams of interweaving of the front part and the back part of the inflated element are approximately 30–40 mm apart, so that the resultant cells are cylindrical when inflated. The total volume of gas within the inflated element may be between 7 and 9 liters, and the gas may be at a pressure of about 3 bar. While the inflated element is not provided with a vent to vent gas from within the element to the atmosphere, so that the inflated element, when inflated, remains inflated for a long period of time—to provide protection in the case of a protracted roll-over—there is venting between at least selected adjacent cells **8**, to avoid any severe rebound. Thus if the head of the person in the vehicle impacts with the inflated element the pressure of gas within the whole element, or at least a substantial part at the element will rise, thus giving a "soft" impact. If each cell were sealed with no venting of this type, there would be a risk of severe rebound.

The weight of the fabric should be kept to be as low as possible, so that if the inflatable element should impact with the head of the person in the vehicle as the inflatable element is inflated no harm will be done. It is thought that a material having a weight of less that 300 g/sq m, such as 175 g/sq m may be used.

It is to be noted that part of the inflated element extends rearwardly beyond the point **11**, and is thus located between the head of the person **1** and the top of the B-post. Thus, the risk of the head of the person impacting with the B-pot is minimized. Since the upper edge of the inflatable element is secured to the upper part of the door frame along substantially the whole of its length, there is virtually no risk that the head of the occupant will pass between the upper edge of the inflatable element and the upper part of the door frame, with the head of the occupant of the vehicle thus inadvertently emerging from the body shell of the vehicle.

FIGS. **2** to **4** illustrate a second embodiment of the invention. In this embodiment, an inflatable element **20** is provided which is initially stored in a recess provided in the door frame **21** of a motor vehicle. A gas generator **22** is provided, which again incorporates or is associated with a sensor or detector which activates the gas generator at an appropriate time. The gas generator is connected by a duct **23** to an inflatable part **24** of the inflatable element **20**. The gas generator **22** is located in the door frame **21** of the vehicle, but alternatively could be positioned in the B-post.

The inflatable part **24** or the inflatable section of the inflatable element **20** is formed from two layers of fabric, as

in the embodiment of FIG. **1**, with the front layer and the back layer of the fabric being woven together at selected points **25**. The selected points **25** are arranged in vertically extending columns and serve to divide the inflatable part **24** into a plurality of vertical parallel chambers. The spaces between the selected points **25** permit internal venting between adjacent chambers.

The inflatable part **24** of the inflatable element **20** is adapted to be located adjacent the head of an occupant of the motor vehicle, and, towards the rear of the inflatable element, when in the position illustrated in FIG. **2**, the inflatable part of the inflatable element extends from the top to the bottom of the inflatable element in a rear region and subsequently, the upper edge of the inflatable part extends downwardly towards the lower edge of the inflatable element, in a sense directed towards the A-Post **26**. The remaining part or non-inflatable section of the inflatable element comprises a web or sheet **27** which extends from the inflatable part **24** to the part of the door frame **21** above the door and to the A-post. The web or sheet **27** is thus secured to parts of the door frame that are non-linear. It is to be appreciated, therefore, that in this embodiment of the invention the upper edge of the inflatable element is of non-linear form and is of the same configuration as the non-linear part of the door frame which extends forwardly from the B-post and which incorporates the A-post. The upper edge of the inflatable element, or at least a substantial part of the upper edge, is securely fixed to the upper part of the door frame, thus again minimizing any risk of the head of the occupant emerging from the body shell between the upper edge of the inflatable element and the upper part of the door frame.

Referring to FIG. **3** the edge of the sheet **27** that is secured to the door frame **21** may terminate with a bead **28** that is received within a slot **29** formed in the door frame, the mouth of the slot being narrower than the base so that the bead **28** can slide axially within the slot, but cannot escape from the slot. A cable **30** is connected to the end of the bead, as can be seen in FIG. **4**, the cable being connected to a tensioning device **31**. The tensioning device may comprise a piston in a cylinder associated with a gas generator to generate gas which moves the piston within the cylinder to apply tension to the cable **30** and thus to the bead **28**. A ratchet or the like may hold the piston in place when it has been moved by the gas. The gas generator that supplies gas to the piston may be the gas generator **22** or may be a separate gas generator that is triggered simultaneously with the main gas generator.

When an accident occurs, the inflatable element **20** moves from its stored position to the operative position shown in FIG. **2**, and tension is applied to the inflatable element **20** by the distention of the inflatable part **24**, and by the tension applied to the bead **28**. The inflated element **20** is thus held firmly in position to provide protection for the head of the person sitting in the motor vehicle. The thickness of the element **20** and the weight of the material used should be as described with reference to the embodiment of FIG. **1**.

FIGS. **5** and **6** illustrate another embodiment of the invention intended to provide protection not only for a person in the front seat of a motor vehicle such as a motor car, but also for a person in the rear seat of the vehicle.

Referring to FIG. **5**, a recess **40** is provided in the doorframe **41** of a motor vehicle, the recess extending over both the front door **42** and the rear door **43**. The recess extends from a point **44** located near the lower end of the A-post to a point **45** located near the lower end of the C-post.

A channel **46** is provided on the B-post, extending vertically. In the channel **46** is a ratchet R, and received within the upper end of the channel **46** is a ratchet engaging slide member **47**. The slide member **47** is connected to a tab **48** which forms part of an inflatable element **49** (see FIG. **6**), which is initially stored within the recess **40**.

The inflatable element **49** is shown in the inflated state in FIG. **6**. The inflatable element has its top edge **50** secured to the part of the door frame **41** that extends above the doors **42**, **43** of the motor vehicle. The top edge of the inflatable element is of non-linear configuration, and has a configuration which corresponds with the non-linear configuration of the upper part of the door frame. The design of the inflatable element is similar to that shown in FIG. **1**, with the inflatable element presenting a plurality of parallel cells, which when inflated are substantially cylindrical. The structure of the inflatable element **49** may be the same as that described with reference to FIG. **1**.

A gas generator **51** is provided which is connected to the inflatable element in such a way that when the gas generator is activated by a sensor that is formed integrally with the gas generator, or which is associated with the gas generator, and which responds to a side impact or to a roll-over situation to activate the gas generator, gas is initially supplied to the cells **52**, **53**, which are aligned with the tab **48**. Thus initially, as the inflatable element **49** inflates, the cells **52** and **53** inflate and move the ratchet engaging slide member **47** downwardly. The ratchet engaging slide member thus moves down the slot **46** to the position shown in FIG. **6**. The ratchet engaging slide member **47** engages the ratchet, and thus holds the tab **48** in its lower position.

The rest of the cells **54** of the inflatable element are then inflated, and the inflatable element then extends fully across the upper parts of the windows in the doors **42**, **43** of the motor vehicle. It can be seen that the lower edge of the inflated element **49** extends between the points **44** and **45** at the ends of the recess **40**. As the inflatable element **49** inflates, so the length of the lower edge thereof decreases as a consequence of the inflation of the cells of the inflatable element. This reduction in the length of the lower edge, together with the action of the ratchet engaging slide member **47** ensures that the inflated element is retained in position as illustrated after it has been inflated.

FIG. **7** is a cross section showing the nature of the cells of the inflated element of FIG. **1** and of FIGS. **5** and **6**. It can be seen that the cells are immediately adjacent to each other and are only separated by narrow regions where the fabric forming the front part of the inflated element has been woven with the fabric forming the back part of the inflated element. However, FIG. **8** illustrates an alternative possibility, in which the regions of fabric between the cells that are woven together are relatively wide, the cells thus being separated by webs of fabric. The advantage of this latter possibility is that a smaller volume of gas may be required to fully inflate the inflatable element, meaning that the inflatable element may be inflated more rapidly.

FIG. **9** illustrates an alternative form of inflatable element comprising a plurality of cells **60** or inflatable sections. The upper edge of the inflatable element is of non-linear form and is connected to the non-linear portion of the door frame above the door. The configuration of the upper edge of the inflatable element and the configuration of the door frame correspond. It can be seen that each cell **60** is of substantially conical form, the cells being arranged adjacent each other and being parallel with each other. Between the cells are inverted triangular portions **61** or non-inflatable sections where the fabric forming the cells is interwoven.

When cells of this type are inflated, the length of the lower edge of the arrangement contracts, whereas the length of the upper edge of the arrangement remains constant.

An arrangement of this type can be used, therefore, to ensure that the lower edge of the element, when inflated, is under some tension.

Whilst in the arrangement illustrated in FIG. **9**, the cells are immediately adjacent each other, it is to be appreciated that a similar effect may be achieved if the cells are spaced apart. It is possible to replace at least part of the inverted triangular region **61** with further conical cells of an inverted orientation.

While in the described embodiments of the invention, the inflatable element has been described as being made utilising a technique in which two layers of fabric are interwoven to define points or lines where the front layer and the rear layer are interwoven, it would be possible to form embodiments of the invention utilising two discrete layers of fabric which are interconnected by stitching.

What is claimed is:

1. A safety device for a motor vehicle having a door frame, the safety device comprising:

a gas generator;

a sensor operatively connected to said gas generator for sensing at least one of a side impact and a roll-over that activates said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected in a plurality of predetermined areas to define regions where the front part and the back part of said inflatable element are secured together forming elongated cells, and where an upper edge portion of the inflatable element is adapted to be secured to at least one anchoring point on the door frame at a level above a door contained within the door frame; and

an extension piece extending from a predetermined area and adapted to be secured to a second anchoring point on the vehicle, whereby, the cells of the inflatable element are configured such that, upon inflation of said inflatable element, the length of the part of said inflatable element between the anchoring point on the door frame and the second anchoring point on the vehicle is reduced so that this part of the inflatable element, together with the extension piece, is tensioned.

2. A safety device according to claim **1**, wherein said inflatable element is made of fabric.

3. A safety device according to claim **1**, wherein the regions defined by the interconnection of the first and second layers form linear links.

4. A safety device according to claim **1**, wherein the regions defined by the interconnection of the first and second layers form point-shaped links.

5. A safety device according to claim **1**, wherein the extension piece is a strap.

6. A safety device according to claim **1**, wherein the extension piece is a web.

7. A safety device according to claim **1**, wherein the extension piece is a sheet.

8. A safety device according to claim **1**, wherein the inflatable element is initially stored in a recess provided in the door frame.

9. A safety device according to claim **1**, wherein there is internal venting between the cells.

10. A safety device according to claim **1**, wherein the cells are immediately adjacent to one another.

11. A safety device according to claim **1**, wherein the cells are spaced from each other.

12. A safety device according to claim **1**, wherein at least some of the cells are of conical form when inflated.

13. A safety device according to claim **1**, wherein the motor vehicle has a B-post and the inflatable element, when inflated, extends past the B-post of the vehicle.

14. A safety device according to claim **1**, wherein the inflatable element is provided with means adapted to move from an initial position to a further position on inflation of the inflatable element, an arrangement being provided to retain said means in said further position.

15. A safety device according to claim **1**, wherein axes of the cells are substantially parallel.

16. A safety device according to claim **1**, wherein said elongated cells are substantially vertical.

17. A safety device mounted in a motor vehicle having an A-post, a door frame, a door contained within the door frame, and a B-post, the safety device comprising:

a gas generator;

a sensor operatively connected to the gas generator for sensing at least one of a side impact and a roll-over for activating the gas generator; and

an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator, the inflatable element having an inflatable section adapted to be positioned adjacent the door and a non-inflatable section, the inflatable element comprising:

a first layer defining a front part thereof;

a second layer defining a back part thereof, selected parts of the first layer and the second layer being interconnected in a plurality of predetermined areas defining a plurality of links between which elongated cells for inflation are defined;

an upper edge portion secured to the door frame at a level above the door at at least one anchoring point; and

an extension piece extending from a predetermined area and adapted to be secured to a point on the A-post of the vehicle, whereby, the cells of the inflatable section of the inflatable element are configured such that, upon inflation of said inflatable element, the length of the part of said inflatable element between the anchoring point on the door frame and said point on the A-post of the vehicle is reduced so that this part of the inflatable element, together with the extension piece, is tensioned.

18. A safety device according to claim **17**, wherein said inflatable element is made of fabric.

19. A safety device according to claim **17**, wherein said elongated cells are substantially vertical.

20. A safety device installed in a motor vehicle having a door frame, the safety device comprising:

a gas generator;

a sensor operatively connected to said gas generator for sensing at least one of a side impact and a roll-over that activates said gas generator; and

an inflatable element connected to said gas generator to be inflated by gas from said gas generator upon activation of said gas generator, said inflatable element comprising:

a first layer to define a front part of said inflatable element;

a second layer to define a back part of said inflatable element, with selected parts of the first layer and the second layer being interconnected in a plurality of predetermined areas to form elongated cells, where at least an upper edge portion of the inflatable element is secured to the door frame at a level above a door contained within the door frame; and

an extension piece extending from a predetermined area and secured to an anchoring point on the vehicle, whereby, the cells of the inflatable element are configured such that, upon inflation of said inflatable element, the length of the part of said inflatable element between said anchoring point on the vehicle and another point where the inflatable element is connected to the vehicle is reduced so that this part of the inflatable element, together with the extension piece, is tensioned.

21. A safety device according claim **20**, wherein the inflatable element has a lower edge having a first end and a second end, the first end of the lower edge being constituted by part of the extension piece, and wherein said another point is located at the second end of the lower edge.

22. A safety device mounted in a motor vehicle having an A-post, a door frame, a door contained within the door frame, and a B-post, the safety device comprising:

a gas generator;

a sensor operatively connected to the gas generator for sensing at least one of a side impact and a roll-over for activating the gas generator; and

an inflatable element connected to the gas generator for being inflated with gas from the gas generator upon activation of the gas generator, the inflatable element having an inflatable section adapted to be positioned adjacent the door and a non-inflatable section, the inflatable element comprising:

a first layer defining a front part thereof;

a second layer defining a back part thereof, selected parts of the first layer and the second layer being interconnected in a plurality of predetermined areas defining a plurality of links between which elongated cells for inflation are defined;

an upper edge portion secured to the door frame at a level above the door, where a part of the inflatable element is secured to the vehicle at a point behind the B-post; and

an extension piece extending from a predetermined area and adapted to be secured to a point on the A-post of the vehicle, whereby, the cells of the inflatable section of the inflatable element are configured such that, upon inflation of said inflatable element, the length of the part of said inflatable element between the secured point behind the B-post and said point on the A-post of the vehicle is reduced so that this part of the inflatable element, together with the extension piece, is tensioned.

* * * * *